Vol. XXII. — No. 4. April 1940.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[656. 231 (.493)]

The new rating policy of the Belgian Railways

by R. HENNING,
Inspecteur en chef, Adjoint au Directeur de l'Exploitation, Belgian National Railways Company.

General.

We are living in a time when all traditions and every doctrine have become matters of controversy. The present state of affairs no longer meets the aspirations of individuals, and organisations no longer fit in the circle to which they belong.

A new order is awaited, but no one yet knows what it will be like.

Experiments and trials are being made in every field. The whole world is experiencing a need for something new, yet fears to break deliberately with the old rules whose wisdom is vouched for by their very age.

The railway likewise — perhaps even more so than other undertakings — has experienced this tendency to criticise the very foundations of its force and fertility. It is prepared to break through the frame enclosing its activities and look for new fields.

There is nothing surprising nor disquieting in this.

A century ago, when the railways took the place of the road carriers, there started a long period of doubt, of groping for the way, of trying out new experiments in turn. In Belgium it took nearly thirty years for the railways to develop a commercial policy capable of harmonising with the requirements of trade and industry.

At the present time this policy is being questioned by some people and critised by others. We will merely state that the policy adopted to date by the Belgian Railways was the same as that followed on all the railways of Europe, in fact by nearly all the railways of the world.

It would not, however, be very reasonable to maintain that this policy should remain immutable when everything else is altering.

It is often affirmed that the railway rates are based on the value of the goods carried. This is only partly true.

In reality, railway rates are inspired by the principle : — *Make the traffic pay as much as it can bear.*

Is such a principle open to criticism ? We do not think so. Does not the same hold true with every other industry where the margin of profit added to the cost price depends to a great extent on what the buyer will pay ? Does not such a principle link up the rate charged with the *commercial value of the transport*, i. e., the additional value of the goods after carriage ?

But how is the amount that each traffic can bear to be determined ?

As it is impossible to fix the commercial value of each transport, the railways have admitted — a more exact solution being lacking — that the higher the price of the goods, the higher the rates they can afford to pay.

It is not necessary to point out that in many cases this postulate is false. The railways know that it is, and for this reason have corrected their general rates when necessary by a great number of special rates; or else certain goods have been grouped into classes which do not correspond with their value.

We agree that the application of the formula : — *Charge what the traffic can bear* — becomes more complicated when it has no monopoly to back it up. As soon as there is competition between carriers, the railway can no longer take the commercial value of the transport into account alone; it must also bear the offers of its competitors in mind.

As soon as this happens, the whole rating policy, the object of which is financial equilibrium, is shaken to its foundations and threatens to collapse.

This is what is happening at the present time.

The Belgian Railways consider that it ought to be possible to retain rates based on the commercial value of the transport. The principle is sound economically and should not be abandoned unless it proves incapable of bringing in sufficient receipts to cover the operating expenses. Should this ever occur, our industrial undertakings would be in grave danger.

The International Chamber of Commerce, during its 1935 Session, proclaimed that *the moment had not come to upset the present rating structure of the railways.*

This resolution carries some weight because it was arrived at after lengthy and painstaking studies in which representatives of the carriers, industry and trade all took part.

We repeat : — Do not be misled into thinking that the railways consider their rates structure as a holy of holies, which must remain inviolate. On the contrary, they are seeking in all sincerity to find out if a new method should not completely make a clean sweep of the past.

They follow with the greatest interest all the theses put forward in this connection, but they have been forced to admit that up to the present nothing, absolutely nothing of any definitive value has been presented.

Innovators state that : *Rates based upon the operating cost are the proper method.*

Does anyone think that the railways are not concerned with the operating cost when drawing up the rates ? If so he would be very simple, because we think everyone knows that the total average operating cost is the basis of the whole rates structure. Under the present method, however, this average cost does not apply uniformly to all kinds of transport.

Do the upholders of the new formula want the operating cost to be uniformly applied ? If so we must state at once that to do so would lead to serious anti-economic and unjustifiable consequences.

If it is maintained that each consignment should pay the carrier what it costs him to carry it, agreed. Such a theory can be defended theoretically, but *only* theoretically. If the *average* operating cost, however, be substituted for the *partial* cost, the formula at once becomes inadmissible.

One school maintains that *transport*

below the average *operating cost encourages waste of goods conveyed under too favourable conditions.* We are forced to think that this is a slip of the pen, as it is inconceivable that the railway should make a paying transport impossible on the pretext that the receipts per ton-mile obtained thereby were less than the *average* cost. Bulk transport, for example, earns large *net* receipts for the railway, though the rate charged per ton-mile is much lower than the *average* carriage cost. If the average operating cost were applied to such transport, a good deal of it could no longer take place.

It is a fact that those who are in favour of rates based on the operating cost, generally confuse the *partial* cost with the *average* cost. It is not inopportune, we think, to recall that rates based exclusively on the *average* operating cost have already been tried and that the results proved disastrous.

Since it is impossible to base the whole tariff structure on the application of the *average* cost to all transport, why should the rates not be based on the *real* cost of the service rendered ?

In investigating this formula, we will not take into account the many factors which temporarily or incidentally may affect the cost. We will only retain those factors which are of permanent value and beyond the control of the operator.

What kinds of transport does the railway carry at a loss ?

As we have already seen, it would be a mistake to think that all transport carried by the railway at a rate lower than the average operating cost means a loss to the carrier. In actual fact traffic involving a loss to the railway is that which is carried over sections of lines where it is insufficient to keep the staff, equipment, and rolling stock required properly occupied.

Transport which involves much shunting or handling en route is also costly, but only in certain cases. Generally this category of expensive transport is covered by that mentioned in the previous paragraph.

This finding — which is closely bound up with the problem of lines showing a deficit — shows how competition, which the railway has every reason to complain about, works.

The road carrier — with reason, moreover — takes good care not to concern himself with what we will call « poor » services. He sets up trade where there is abundant traffic, or at any rate sufficient traffic to make his undertaking profitable.

And even here he selects what goods he will carry, and it is always just those goods that the railway carries at a rate definitely higher than its average operating cost.

The consequences thereof are obvious : — Goods which have to pay high rates, without this making it impossible to carry them, are lost to the railway, with the result that its receipts per unit of traffic decline, and its financial equilibrium is imperilled.

What remedy is there for such a situation ?

If we agree with the thesis of those who think that all the rates should be based on the operating cost, the railway would have to lower its rates where the traffic is heavy, and increase them where it is « poor ».

This is no doubt a solution, but we do not think it is a practical one.

In services with heavy traffic, road transport has left the railway to carry a tonnage greatly in excess of that carried on the « poor » services. A reduction of about 40 % in the rates — perhaps 60 % in certain cases — would involve a considerable loss of *net* receipts.

If such a loss were to be made good,

the rates applied on the « poor » services would have to be increased to such an extent that it would be impossible to transport the goods.

This shows the impossibility of such a solution. It must, however, be added that such a policy of discrimination would also have serious effects on the general economy, as it would leave certain districts without any services to link them up, make it impossible to exploit natural sources of wealth lying outside the important traffic currents, and lead to inequality between individuals which could not in fairness be tolerated.

To avoid such discrimination entails a return to the mutuality which hitherto has been one of the essential factors in railway rates. Mutuality as between goods, and mutuality as between services. The expensive goods pay for the cheap goods; the « prosperous » services cover the deficits of the « poor » services.

However, the ever increasing activity of road transport has jeopardised such mutuality. Industry and trade have two carriers to choose from : rail or road. Where will their choice fall ? On the one who will carry out their requirements at the lowest cost.

The road will be given the products which the railway includes in the higher categories of rates, and the railway will continue to get the goods it carries at reduced rates.

Compensation between the two traffics, which took place almost automatically before the advent of the automobile, i. e. when the railway enjoyed an actual monopoly, therefore no longer occurs. The individualistic policy of consignors and consignees has made it impossible.

Since it is necessary, however, that the present structure of railway rates shall not be upset, this mutuality action must not be tampered with. How can it be maintained ? By meeting the individualistic policy of consignors and consignees by an individualistic rating policy.

The railway will only let those who send their higher rated goods by rail profit by the reduced rates. In this way, the compensation which formerly took place over the traffic as a whole, will be made on the traffic of each consignor or consignee.

The new rating policy of the Belgian Railways, which came into force on the 1st January, 1939, is based on this principle.

Experience has not yet been long enough to form a judgment on the results. It may, however, be stated without prejudice to the future that the figures for the first months of 1939 have not contradicted the hopes which the Belgian National Railways Company has placed in the new policy analysed below.

* * *

Passenger rates.

Having decided to make a radical change in its goods rates, the Belgian National Railways Company thought it advisable to also make a few changes in its passenger fares at the same time.

There are a great many cheap fares. Some of these are due to a desire to increase the traffic and should be maintained.

Others are not justified by traffic considerations. Those profiting by such cheap fares could pay more without inconvenience.

Diagram No. 1 shows how the number of passengers travelling at cheap fares has increased since 1926, while the number of full-fare passengers decreased correlatively.

Cheap fares are always a given percentage of the full fare. How then were the cheap fares to be increased without

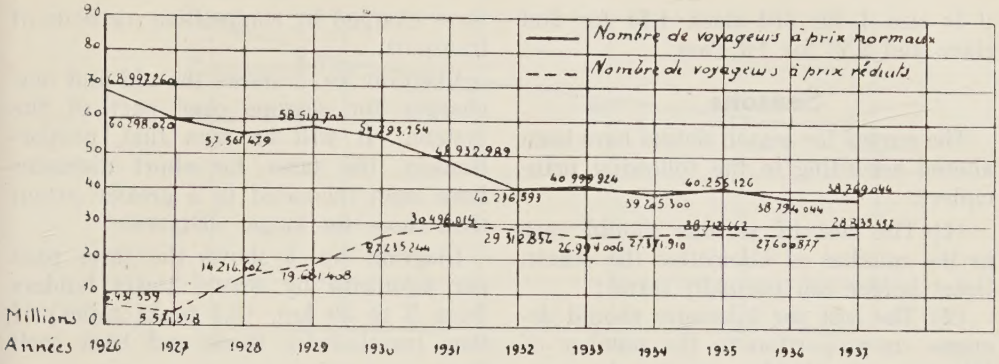


Diagram No. 1.

Note. — Nombre de voyageurs à prix normaux = number of full-fare passengers. — Nombre de voyageurs à prix réduits = number of reduced-fare passengers.

at the same time affecting passengers paying the full fare ?

To solve this problem the Belgian National Railways Company increased the 3rd-class fare per kilometre from 27.1 to 32 centimes, i. e. an increase of 18 %, but reintroduced at the same time return tickets, with a 20 % reduction on the cost of two single tickets.

In this way the reductions are all calculated on the cost of two single tickets.

The table below shows the resulting reductions and increases for the different categories of passengers.

Before the war, 70 % of passengers taking tickets obtained a reduction on the journey back. There were then very few special reduced fares.

If we agree that the same proportion of full-fare passengers now take return tickets, the obvious deduction is that nearly all full-fare passengers obtain a 6 % reduction.

The increase of 18 % will therefore only affect those passengers already obtaining reductions. Are they likely to complain ? We do not think so.

In actual fact, those who profit by a 50 % reduction will find it reduced to

Passengers travelling « there and back ».	3rd-class fare per kilometre		Reduction, %	Increase, %
	before the 1st January, 1939.	since the 1st January, 1939.		
Full fare	0.271	0.256	6 %	...
50 % reduction	0.136	0.16	...	18 %
75 % reduction	0.068	0.08	...	18 %

Week-end tickets with a 25 % reduction on the cost of two single tickets have been kept, but with an increase of 18 %, but are only valid from Saturday to Monday, whereas an ordinary return ticket is valid for 4 working days.

37.5 % and a 75 % reduction will become 68.75 %.

This is, admittedly, a still appreciable reduction.

The difference between the fares in the three classes has not been altered;

it is still 1 for 3rd class, 1.74 for 2nd class, and 2.53 for 1st class.

Seasons.

The curves for season tickets have been altered according to the following principles :

(1) The cost of seasons should vary as the number of kilometres the season ticket holder can normally travel;

(2) The cost per kilometre should decrease in proportion to the number of kilometres the holder can travel;

(3) Over short distances, the cost of seasons should take into account the fares charged by competitive methods of transport.

Diagram No. 2 shows the old and new charges for seasons over part of the system. It will be seen that, proportionally, the fares for short distances have been increased to a greater extent than those for longer distances.

Diagram No. 3 shows the fares paid per kilometre by season ticket holders from 5 to 50 km. (3.1 to 31 miles) if they travel twice there and back each day.

Diagram No. 4 shows how much the season ticket holders pay per kilometre,

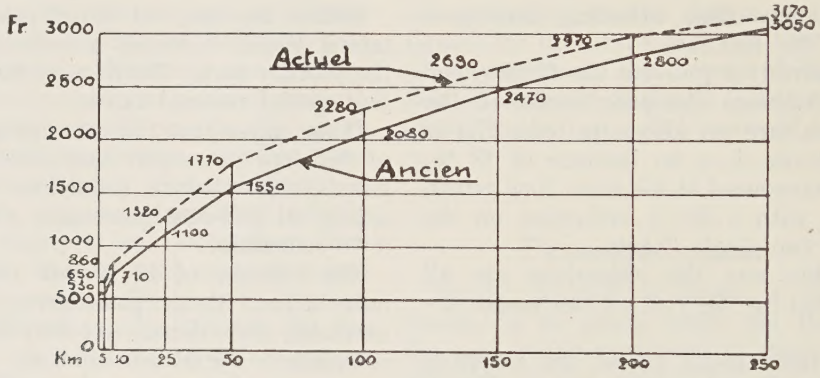


Diagram No. 2.

Note. — Actuel = present day. — Ancien = former.

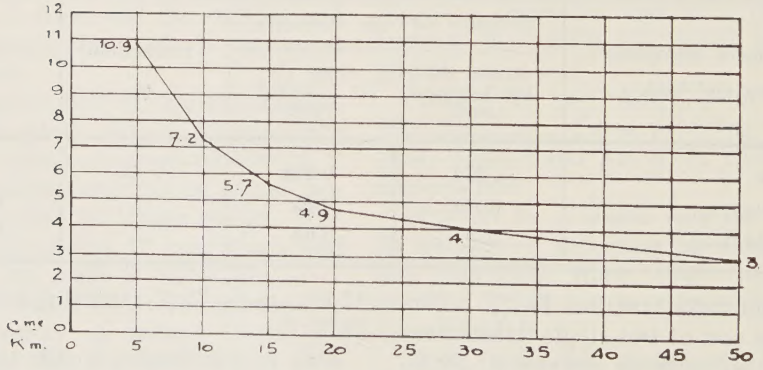


Diagram No. 3.

Note. — Cme = centimes. — Km. = kilometres.

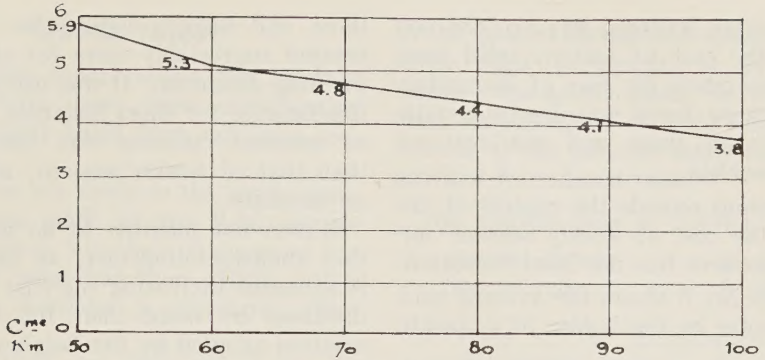


Diagram No. 4.

from 51 to 100 km. (31.6 to 62 miles) if they travel once there and back daily.

A great number of workers only make one return journey daily, however, and these might consider a charge, based on two return journeys a day, excessive.

For their benefit, a special season ticket called « workers' season » has been introduced.

These are only sold to manual or intellectual workers whose remuneration does not exceed 24 000 fr. per annum.

When such seasons were introduced, the question arose how the railway was to check that only one journey there and back was made daily. All the methods considered always led to vexatious complications for the passenger, or complicated and expensive red tape for the railway.

A simple solution was adopted : Workers' seasons cannot be used on Sundays or holidays, nor between 11 a. m. and 2 p. m. on working days, except Saturdays.

This does not make misuse absolutely impossible, but has the great advantage of simplicity whilst reducing the risk of fraud to a minimum.

Diagram No. 5 shows the curve of the charges for ordinary seasons and workers' seasons.

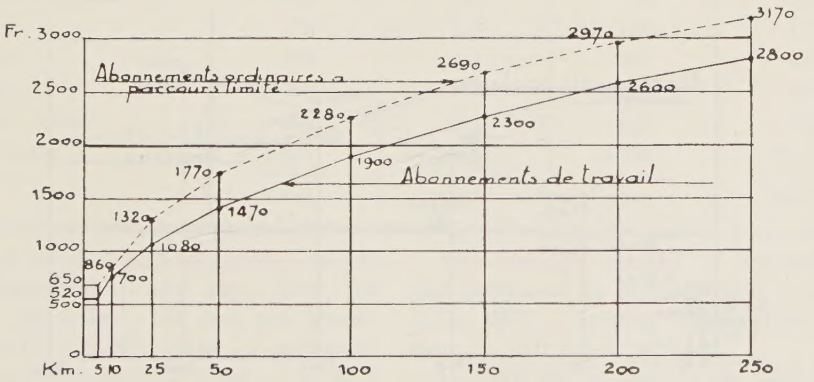


Diagram No. 5.

Note. — Abonnements ordinaires... = ordinary seasons valid on part of the system only.
Abonnements de travail = workers' seasons.

The Belgian National Rys Co. did not increase the cost of seasons valid over the whole system for fear of increasing the difference there may be in certain cases between these and the cost of mileage-booklets.

For reasons outside the control of the railway, the cost of weekly seasons for manual workers has not been increased.

Diagram No. 6 shows the amount paid per kilometre by the holder of a weekly season.

Seasons for scholars for 6 journeys there and back a week have been increased appreciably more for short than for long distances. It was decided to do this because for short distances the price of scholars' seasons was much lower than that of weekly seasons, which was an anomaly.

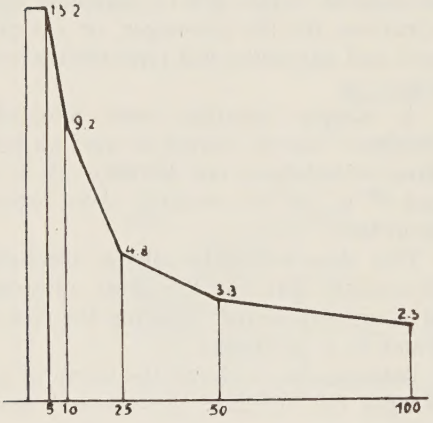


Diagram No. 6.

It was not possible to do away with this anomaly altogether, as this would have meant increasing the cost for short distances by more than 100 %. The solution adopted by the Belgian National Rys. Co. was therefore due to psychological considerations.

Diagram No. 7 shows the curves of charges for scholars' seasons, both former and new, as well as those for the cost of a weekly season.

Scholars' seasons for less than 6 journeys are no longer issued, but pupils and students can get a card entitling them to a reduction of 75 % on the cost of a single ticket, though the fare paid must not be less than 10 francs for a single journey and 15 francs for an inward and outward journey.

If the distance is over 10 km. (6.2 miles) it is cheaper to get a 6-journey season when travelling more than twice a week.

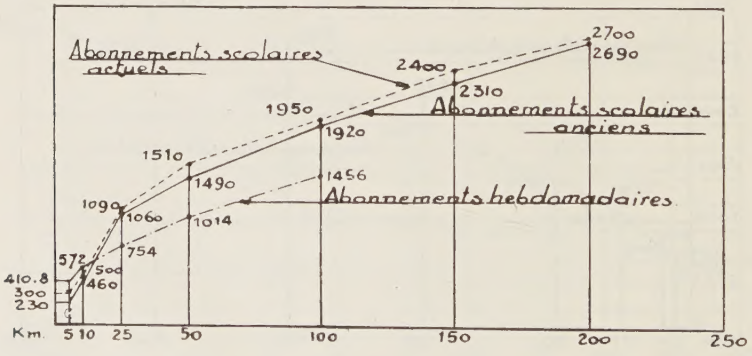


Diagram No. 7.

Note. — Abonnements scolaires actuels (anciens) = present-day (former) scholars' season tickets. Abonnements hebdomadaires = weekly seasons.

Goods rates.

The above report shows that though the old fares have been considerably changed, their bases have not been modified.

This does not apply to the goods rates. The changes made in this field require little comment, but their application has undergone what has been called, rather pompously perhaps, a structural alteration.

This reform has been based on the considerations developed in the beginning of this article.

In 1938, the average receipts per tonne-kilometre were 32.3 centimes.

From this statement one might deduce that all the tariff scales, whose charges per tonne-kilometre over the average distance exceeded 32.3 centimes, should not be increased in any way. Now, for 100 km. (62 miles), the cost per tonne-kilometre in the 8th class — generally the lowest rated general class — is 34.2 cms.

This thesis could be accepted if the difference between the tonnage carried in the general classes and that carried at lower rates — special or exceptional rates — was not too great. In 1938, however, only 29 % of the total tonnage was carried at the general rates, and 71 % profited by reduced rates.

The receipts were as follows :

General classes	41 %
Special rates	59 %

A study of the distribution of the tonne-kilometres between the different classes and the special rates in 1931 as compared with 1937 is highly instructive. From the point of view of economic production these two years were very similar.

The table hereafter makes this comparison clear.

—	1931 Millions of tonne-kilometres.	%	1937 Millions of tonne-kilometres.	%
1st class	58	0.9	33	0.5
2nd class	116	1.9	45	0.7
3rd class	42	0.7	27	0.4
4th class	118	2.0	73	1.2
5th class	338	5.6	92	1.5
6th class	118	2.0	103	1.7
7th class	384	6.4	307	4.9
8th class	393	6.5	231	3.7
9th class (Coal)	803	13.3	598	9.6
Special rates	3 657	60.7	4 721	75.8
	6 027	100.0	6 230	100.0

The tonnage carried at special rates had increased by 15 % in 1937 compared with 1931. Another observation, however, is still more pertinent.

In 1931, the tonnage in the first 5 classes was 11.1 %; in 1937 it was 4.3 %.

That in classes 6 to 9 was 22.2 % in 1931, and 19.9 % in 1937.

The ravages of road competition, as is logical, have only affected the goods in the first 5 classes.

The number of tonne-kilometres carried in these classes fell from 672 millions in 1932 to 270 millions in 1937.

Obviously, under these conditions, any increase in the rates for these classes would merely have encouraged further loss of traffic to the road.

Such fear was less justified in the case of goods in the other classes.

These considerations led the Belgian National Rys. Co. to draw up its new rates as follows :

The rates for classes 1 to 5 remain unchanged;

The rates for classes 6, 7, 8 and 9 are increased by 10 %;

The special rates Nos. 105, 124, 136, 138 and 141 are increased by 15 %.

The different goods coming under these special rates are : —

Special rate 105 : Cereals, flours;

Special rate 124 : Cinders, slag in lumps, material used for fills;

Special rate 136 : Rubble-stone, quarry refuse, sand, crushed slag;

Special rate 138 : Lime clinker, sugar factory waste;

Special rate 141 : Lime phosphates, basic slag.

Diagram No. 8 shows the curves for the rates — Series C — for classes 1 to 9 and the 5 special rates affected by these increases.

The consignor can, however, obtain exemption from any increase if he promises : —

(1) to send by rail for a year, both to and from his premises, beyond a radius of 20 km. (12.4 miles) all his less than wagon load consignments and the goods coming under the first 5 classes; and

(2) to obtain for the railway by means of the traffic he sends away under (1) quarterly receipts of at least 5 000 francs.

There is no complication in any of these principles, but, to apply them, simple formulæ had to be found.

For the sake of clarity we will call the unaltered scale of rates, A, and the increased scale, B.

When a consignor who has agreed to the « fidelity clause » sends goods for carriage, the waybill is inscribed : *Special rate 100.*

The departure station calculates the amount due according to the unaltered rates, whether it is a question of goods sent carriage forward or carriage paid.

There is no difficulty in this case.

But let us take the case of a consignor who has not. Here it depends on the consignee whether scale A or scale B is to be applied. The departure station, however, has no knowledge on the subject.

If the consignor is not bound by the fidelity agreement, the waybill will *not* be headed *Special rate 100*, and the departure station will calculate the rate according to scale B, whether the consignment is sent carriage paid or carriage forward.

If the consignee also has made no agreement with the railway, the rate charged by the departure station will hold good.

If, however he has made such an agreement, what then ? In this case we must consider two possible situations : the consignor has sent the goods either carriage forward, or carriage paid.

If sent carriage forward, the arrival station will alter the rate shown on the waybill in agreement with scale A. The charges have in fact been calculated by

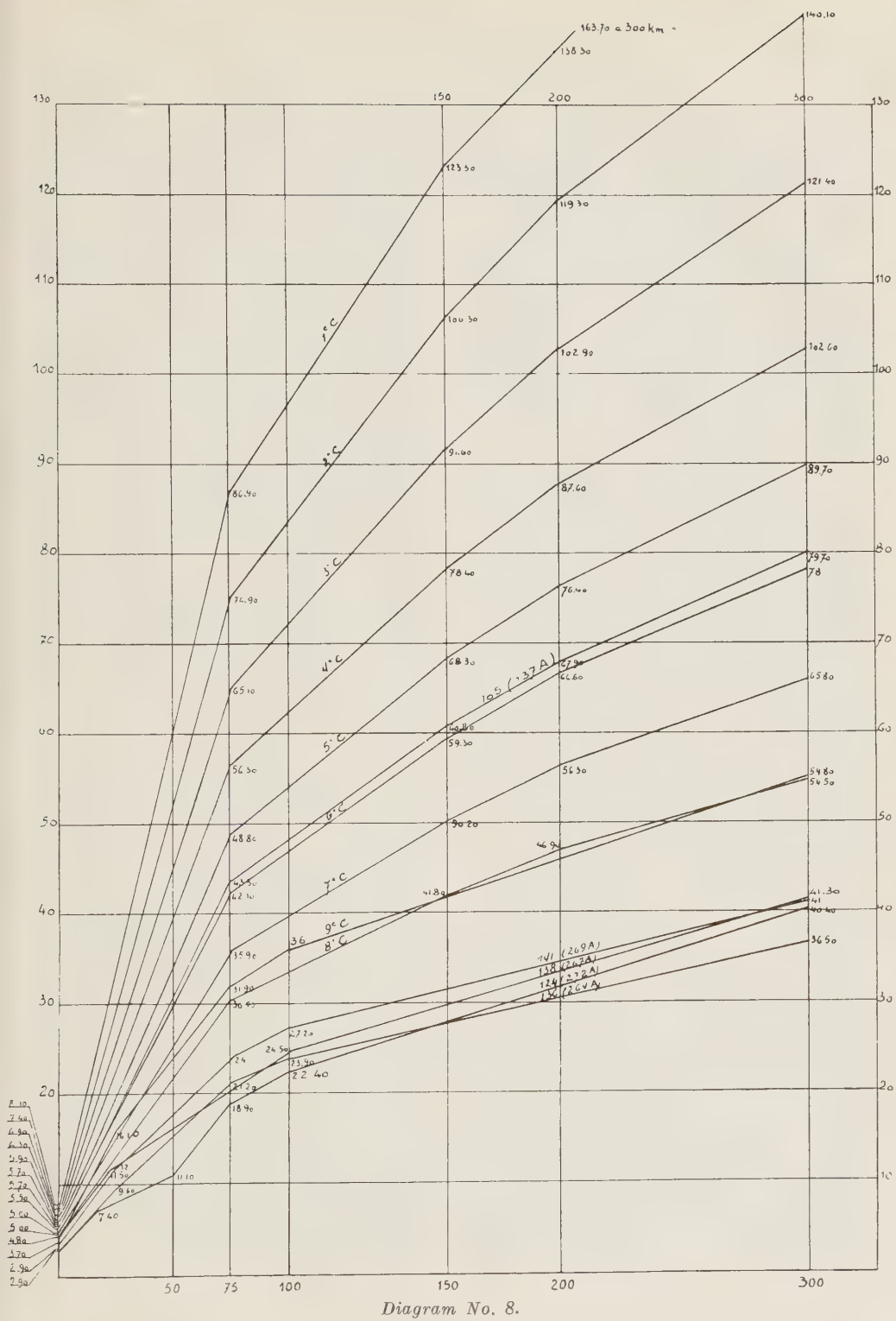

163.70 a 300 km
158.30
143.10
123.30
121.40
119.30
102.90
102.60
100.30
91.60
89.70
87.60
86.90
78.40
78
76.40
74.90
68.30
65.10
66.60
65.80
59.30
56.30
56.50
48.80
42.10
41.30
41
40.40
36.50
31.90
30.60
24.50
24
22.40
18.90
11.10
9.60
7.40
1°C
2°C
3°C
4°C
5°C
6°C
7°C
8°C
9°C
105 (137 A)
141 (269 A)
138 (265 A)
124 (238 A)
120 (264 A)
130
120
110
100
90
80
70
60
50
40
30
20
10
50
75
100
150
200
300

Diagram No. 8.

the departure station according to scale B. The consignee will therefore only have to pay the former, not the increased, rate.

If the consignor sent the goods carriage paid, the departure station will correct the charges according to scale A *and pay the consignee the difference between the charge according to scale A and that according to scale B, paid by the consignor, although the consignee has not had to pay anything for the transport.*

The « faithful » customer therefore always reaps the benefit of his fidelity.

It will be noticed that this procedure frequently makes it necessary for the arrival station to rectify the rate charged by the departure station. According to the usual accountancy methods used on the Belgian National Rys. Co., each such change would require the drawing up of a « corrected charge note » sent by the arrival station to the departure station, which in each case would have had to alter its accounts accordingly. This would have led to a far too complicated exchange of « corrected charge notes » and the accounts would have become practicably illegible.

To get over these two drawbacks, the arrival station on having to correct a charge, notes in one column the charge according to scale A and in a second column the difference between the charge according to scale B and that according to scale A. Adding up the figures in the two columns should agree with the amount entered on departure.

Special cases.

The rates system which we have broadly described should cause each consignor and consignee to calculate if it be to his advantage to agree to the fidelity clause and in this way be exempt from paying the higher rates, or if it be better for him to pay the additional amount and remain free.

In actual fact, such freedom means sending his goods by lorry — whether by his own lorries or those of a carrier — in the case of goods in classes 1 to 5.

There are, however, a great number of firms who get their raw materials delivered by water, their fuel by rail, and send their finished products by road.

In such cases — and they are very numerous — the railway can only charge the higher rates in the case of the fuel.

This made it necessary to ensure that the collieries could not enter into the fidelity agreement with the railway, as if they did all the coal or coke traffic would have been exempt from the rate increase. The scope of the « structural reform » would have been greatly restricted in this case, as the fuel traffic represents nearly 45 % of the total traffic.

Collieries, therefore, have not been allowed to benefit by the reduced rates, but on the other hand, the consignments sent to them : wood, oil, etc., only have to pay charges according to scale A.

Another special case arose.

Certain industries, porphyry and grit quarries, or sandpits, for example, do not produce any of the goods in classes 1 to 5, whereas most of the goods they send by rail profit by the special rates now increased by 15 %. Will such industries have to pay these higher rates for all their consignments ?

A distinction has been made between those industries who send their goods to consignees able to subscribe to the fidelity agreement, and those whose clients cannot possibly enter into such an agreement.

The sand-pits, for example, send most

of their products to the glass-works who can enter into the fidelity agreement. The greater number of the clients of the porphyry and grit quarries, on the other hand, are public bodies (State, provinces, boroughs) who cannot make such agreements.

Under these conditions, no special measure was to be introduced in favour of the sand-pits, whereas an amendment of the rate is justified in the case of porphyry and grit quarries.

In the case of the latter, a special rate has been introduced : the increase of 15 % on special rates 124 and 136 has been reduced to 5 % if the quarry promises to send the whole of its traffic by rail.

Less than full-wagon loads.

All the measures with which we have dealt above relate exclusively to transport worked in complete wagon loads. Motor competition, however, chiefly attacks small consignments.

Consequently something had to be done about these latter as well.

The rates for less than full-wagon load consignments have been increased by 10 %, but the consignor can obtain exemption from this increase if he promises to send all his traffic by rail beyond a radius of 20 km. (12.4 miles). He must also guarantee minimum annual receipts of 10 000 fr. from less than wagon load consignments and 1st class goods.

Let us consider the difference between the policy adopted in the case of *full-wagon loads* and *less than wagon load* consignments.

In the case of *full-wagon loads,* the client has to promise to send all his traffic by rail — both to and from his premises — in the case of goods in classes 1 to 5. He is free to use other methods of transport in the case of goods in the other classes.

In the case of *less than wagon load consignments,* the client only promises to send his outwards traffic by rail. He is free to have goods sent to him by road or by water.

Why such a difference ?

In the case of *full-wagon loads,* the possibility of water transport must not be overlooked and the railway did not want its tariff reforms to be considered as directed against this method of transport. The customer is therefore free to send and receive goods which do not come in classes 1 to 5, by water.

Small consignments are not, as a rule, carried by water. Road competition is the only factor to be considered in this case, and for this reason the consignor, if he wants to be exempt from the higher rates, must promise to send all his goods by rail. As for consignments sent to him, these will or will not pay the higher rates according to whether the consignor — i. e. the seller — has or has not subscribed to the fidelity clause.

It may be taken for granted that — all other things being equal — a trader will prefer to give his orders to the supplier profiting by the lowest transport rates.

If the different policy as regards full-wagon loads and less than wagon loads is logical, it is also inspired by a desire for simplicity.

If such a solution had not been adopted, the railway would have had to make thousands of adjustments every day, every time a consignment was sent by someone who had not agreed to the fidelity clause to someone who had. These innumerable corrections would have given countless complications, the more so that the great majority of consignments are paid for by affixing stamps.

Summary.

The Belgian National Rys. Company has no illusions about the efficacy of the new rates system it has adopted.

It merely wanted to make its commercial policy harmonise with the new conditions : The consignor who only sends by rail those goods whose commercial value is low from a transport point of view should not, either logically or fairly, obtain rates which are only possible thanks to the higher amounts charged for other products.

The system adopted on the 1st January, 1939, is only a small experiment. If the railway finds that the rate increases charged in the case of customers who have not made an agreement with the railway are insufficient to meet road competition, they will be further increased. There is a sufficient margin in this connection, since over a distance of 100 km. (62 miles) the increased rates per tonne-kilometre are : —

6th class	47.8	centimes
7th class	40.7	»
8th class	34.2	»
9th class	36	»
Special rate 105 . .	42.7	centimes
» » 124 . .	19.4	»
» » 136 . .	20.7	»
» » 138 . .	21.2	»
» » 141 . .	23.6	»

Obviously, road transport can hardly ever offer such cheap rates. In addition, the railway keeps in reserve many other special rates, which also could be increased if necessary.

It is to be hoped that these new rates will be cancelled when effective co-ordination of the different methods of transport has been achieved. But this is not certain.

The very principle of the new system is, in our opinion, in perfect harmony with the present position as regards transport. It has, in addition, the advantage of being equally applicable to consignors who use their own lorries and those who deal with private carriers. Now, in Belgium as no doubt in other countries, the number of motor vehicles belonging to industrial firms themselves is very much greater than the number owned by private carriers. If the latter only were controlled, the problem would still be very far from being solved.

In deciding to adopt this tariff reform, the Belgian Railways took care not to let it affect water transport. It should not be deduced from this that competition from the latter is henceforth of no moment. But the reform in question is specifically a means of defence against ill-regulated motor competition. It is an attempt to limit the havoc wrought by the latter, and protect the railway rating policy which is founded on the commercial value of the transport carried.

Competition from water transport does not endanger this policy since, in most cases, only goods of small value are transported by waterways. The railway, of course, does not disdain to carry such goods which, on account of their bulk may affect the unit operating cost, but to retain such traffic there is no need for general measures. The policy of special rates which has been in force almost since the very inception of the railway is sufficient.

[621. 43 (.44)]

High-power railcar engines of French manufacture

by CHARLES TOURNEUR,
Ingénieur principal, Chef de la Division d'études autorails, French National Railways Company.

(Traction Nouvelle.)

The evolution of French standard gauge railcars has, up to the present, been characterised by a constant increase in the power of the engines equipping such vehicles, and the causes of this increase may be summed up as follows :

(*a*) An increase in the capacity of the railcars, imposed by the conditions of employment of this rolling stock, which was primarily intended for the economical operation of branch lines, and afterwards employed on various services handling larger numbers of passengers and running at higher commercial speeds;

(*b*) The advantage of possessing a sufficient margin of power to be capable of hauling an ordinary vehicle, at least on certain services;

(*c*) The extension of railcar services to lines in very hilly country;

(*d*) The necessity of increasing the power/weight ratio, for the dual purpose of improving the performances and reducing maintenance costs, by avoiding the frequent running of the engines in the neighbourhood of their nominal horse-power.

For railcars with a single body and having a large capacity, the body length of which has now reached the maximum admissible (approximately 27 m.=88 1/2 ft.), the conditions (*b*) and (*c*) mentioned above lead one to forecast an installed power of about 500 to 600 H.P.

This power is obtained, on certain railcars, by means of two engines, each of 250 to 300 H.P., which have already been employed for several years, and the working of which is of sufficient reliability at the present time. But, on account of the advantage to be obtained, from the point of view of economy, by the use of a single engine, two French engine builders have constructed high-speed diesel engines of 500 H.P., which it will also be possible to use on multiple-unit railcars, whereon powers of at least 1 000 H.P. are required.

We propose to describe these new designs :

— The 504 type engine constructed by the Renault Works, the prototype of which was tested in January, 1937, and which is mounted in fifteen railcars of the French National Railways Company;

— The 8 DV 120 type engine, constructed by the « Compagnie Lilloise de Moteurs », which has recently successfully passed its acceptance tests, and which will be fitted, in particular, in the high-speed propeller-driven railcar set for the Northern Region, and in a Somua railcar with mechanical transmission under construction for the South-Eastern Region (France).

The table hereafter summarises the leading characteristics of these engines.

Engine data.	Units.	Type 504 Renault engine. of 500 H.P.	Type 8 DV 120 C. L. M. engine, of 500 H.P.
Number of cylinders	...	16, Vee type.	8, in line, with opposed pistons.
Cycle	...	4-stroke	2-stroke
Nominal speed	r. p. m.	1 500	1 500
Bore	millimetres (*inches*)	156 *(6 5/32")*	120 *(4 23/32")*
Piston stroke	millimetres (*inches*)	180 *(7 3/32")*	150 × 2 *(6" × 2)*
Total cylinder capacity	litres (*cu. in.*)	55.1 *(3 363)*	27.12 *(1 655)*
Empty weight, including pumps, dynamos and starters	kgr. (*lb.*)	3 665 *(8 080)*	2 100 *(4 630)*
Overall dimensions of engines — length	metres (*ft.-in.*)	2.77 *(9' 1")*	2.23 *(7' 3 25/32")*
Overall dimensions of engines — width	metres (*ft.-in.*)	1.45 *(4' 9")*	0.67 *(2' 2 3/8")*
Overall dimensions of engines — height	metres (*ft.-in.*)	1.80 *(5' 10 7/8")*	1.62 *(5' 3 25/32")*
Power per litre (*per cu. in.*) of cylinder volume	H.P./litre (*H.P./cu. in.*)	9.1 *(0.149)*	18.4 *(0.3015)*
Weight per H.P.	kgr./H.P. (*lb./H.P.*)	7.3 *(16.1)*	4.2 *(9.3)*
Average piston speed	m./sec. (*ft./sec.*)	9 *(29.5')*	7.5 *(24.6')*
Average theoretical pressure	kgr./cm² (*lb./in.²*)	5.45 *(77.5)*	5.52 *(78.5)*
Injection pressure	kgr./cm² (*lb./in.²*)	300 *(4 267)*	210 *(2 987)*
Compression ratio	kgr./cm² (*lb./in.²*)	14.7 *(209)*	15.9 *(226)*
Consumption of fuel-oil (at 10 500 cal./kgr. = 18 900 B. T. U./lb.) — full load at 1 500 r. p. m.	gr./H.P.-hour (*lb./H.P.-hour*)	190 *(0.425)*	180 *(0.402)*
Consumption of fuel-oil (at 10 500 cal./kgr. = 18 900 B. T. U./lb.) — half load at 1 500 r. p. m.	gr./H.P.-hour (*lb./H.P.-hour*)	230 *(0.514)*	205 *(0.458)*
Consumption of lubricating oil	gr./H.P.-hour (*drams/H.P.-h.*)	6.5 *(3.72)*	5 *(2.29)*

In order to complete the table of high-speed diesel engines of 500-H.P. and over, used on French railways, we shall also give a few details with regard to the experimental application of supercharging to one of the 410-H.P. Maybach engines on the fast triple railcars (TAR) of the Northern Region.

500-H.P. type 504 Renault engine.

The new Renault engine, of 500 H.P. at 1 500 r. p. m., had its design based on the 300-H.P., type 517 engine, several hundreds of which are now working in numerous railcars of the French National Railways Company. It is a four-stroke V-type engine, with direct injection. The maximum engine speed of 1 500 r. p. m. has been retained in spite of the power increase, so as to remain within the acceptable weight limits. The need for ensuring the robustness indispensable for traction purposes led the designers to adopt a comparatively low single-cylinder volume — 3.45 l. (210 cu. in.) — and consequently many cylinders — sixteen.

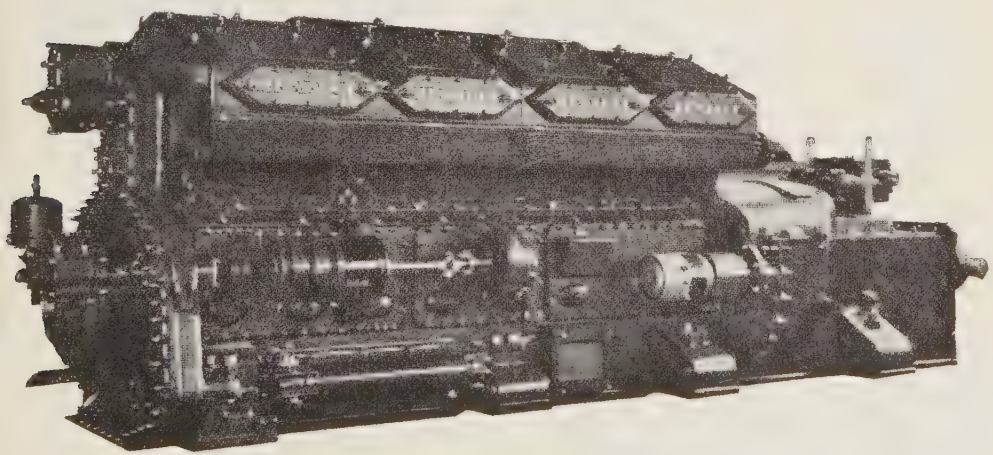
The crankshaft, which is made of special heat-treated steel, with a tensile strength of 115 kgr./mm² (73 tons/sq. in.), runs in nine bearings, lined with anti-friction metal. These bearings are interposed, without caps, between a lower half case made of light alloy, and the cylinder bed, which is also made of light metal. These half cases are held together by stud-bolts.

Numerous inspection openings give easy access to the various parts, and, in particular, enable the bearings of the rods to be replaced.

Each pair of pistons is connected to the corresponding crank by means of a set of connecting rods composed of a main driving rod and a small rod connected to the former by a pin made of hardened steel running in a sleeve made of high tensile gun-metal (similar in arrangement to that of the 300-H.P. engines). The brasses of the connecting rod big-ends are of lead-bronze. The pistons, which are made of hyper-silicon aluminium alloy, with a floating gudgeon pin, held laterally by stops on the piston, are fitted with six rings, of which two are scraper rings.

As on the 300-H.P. engines, the cylinder liners, made of special cast iron, are of the wet type, and the individual cylinder heads are fitted with four valves, two admission and two exhaust. The valves are operated by a single cam shaft, with thirty-two cams, arranged in the middle of the « vee ».

The injection pump, also arranged in the « vee », is composed of an aluminium gearcase in which a shaft with sixteen cams running in five bearings is housed. Four 4-cylinder PM pump elements are fitted on the gearcase, and these are



500-H.P. 16-cylinder V-type Renault diesel engine.

driven through roller push rods. The pump is controlled by a speed regulator and an advance injection controller which effects adjustment of the injection in proportion to the speed of the engine.

Lubrication of the engine is ensured by two gear-driven pumps; one forces the oil through two filters and two coolers (water cooled) and the other takes this oil and sends it to the parts to be lubricated. The working of these two circuits is as follows :

On starting, the lubricating pump sucks up from the gearcase, through a metal strainer, and forces the oil into the lubricating circuit. During this time, the circulating pump forces almost the whole of its feed through a discharge valve calibrated at 1.5 kgr./cm² (21.3 lb./sq. in.), and fitted in advance of the filters and coolers, this on account of the fact that the cold and viscous oil requires too much pressure to be forced through the two auxiliary parts named. As the engine warms up, the discharge valve closes itself, all the oil is forced through the filters and coolers, and reaches the inside of the strainer of the lubricating pump. This pump thereupon ceases suction through its metal strainer and only takes the filtered and cooled oil supplied by the circulating pump.

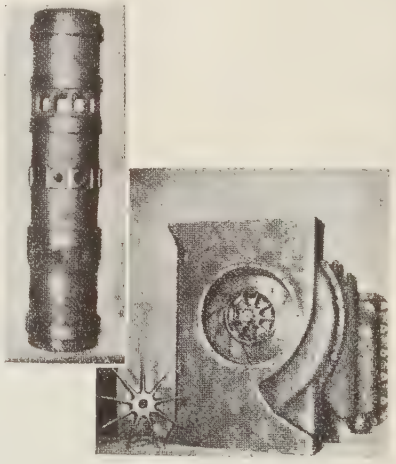
Purification of the oil is moreover effected by a centrifugal device which is fitted in parallel on the lubricating circuit.

The first illustration is a general view of the engine.

The engine successfully passed the 72 hours' test at the nominal load and speed during the contest organised by the Automobile Club of France. The engines of the same design, which since then have been delivered to the French National Railways Company, have without difficulty passed the same tests under the control of the Engine Acceptance Department. Under peak load, the engine developed for one hour a horsepower of 550, and at peak speed, it maintained, for one quarter of an hour, at 500 H.P., a speed of 1 650 r. p. m. On being dismantled after the test, the parts were found to be in satisfactory condition.

500-H.P. type 8 DV 120 C. L. M. engine.

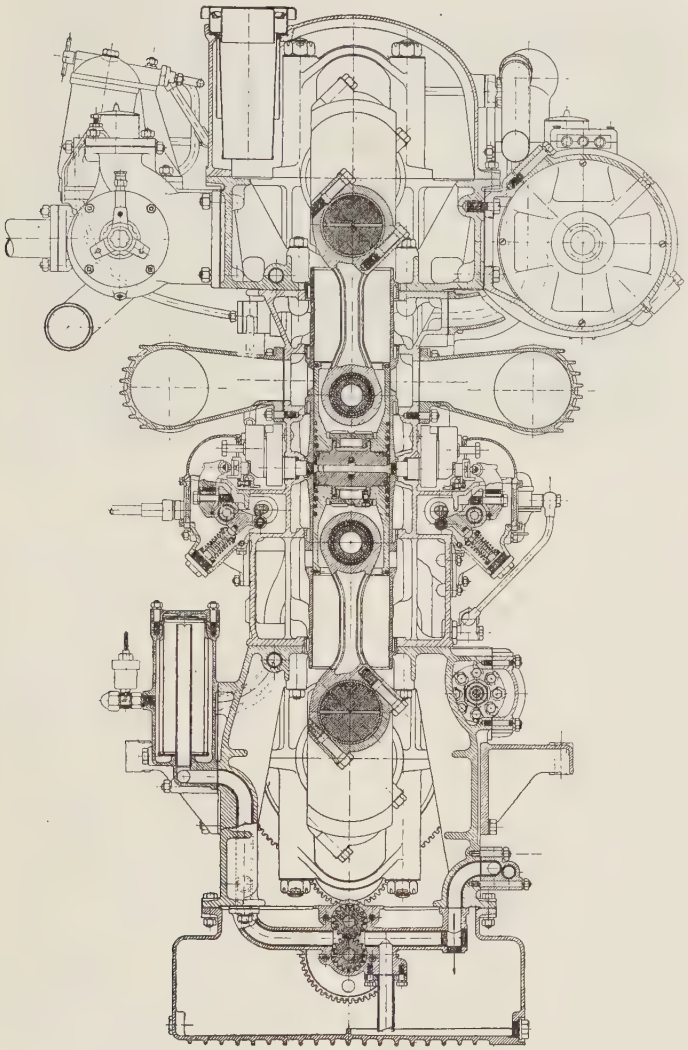
This engine, similar in design to the 250-H.P. engines, of the 4 DV 120 type, several units of which are in service, was like these latter, designed entirely by the « Compagnie Lilloise de Moteurs ». The 8 DV 120 engine, having a nominal horse-power of 500 at 1 500 r. p. m., is of the two-stroke type, comprising eight cylinders with two opposed pistons. The upper pistons drive on to a crankshaft arranged in the top portion of the engine, whilst the other pistons



Cylinder liner and scavenging compressor for the 500-H.P. C.L.M. engine.

drive a crankshaft running in a gearcase underneath; these crankshafts are connected one with the other by a train of gears, with two intermediate pinions (1). Towards the bottom end of the cylinder

(1) The two crankshafts therefore turn in opposite directions.

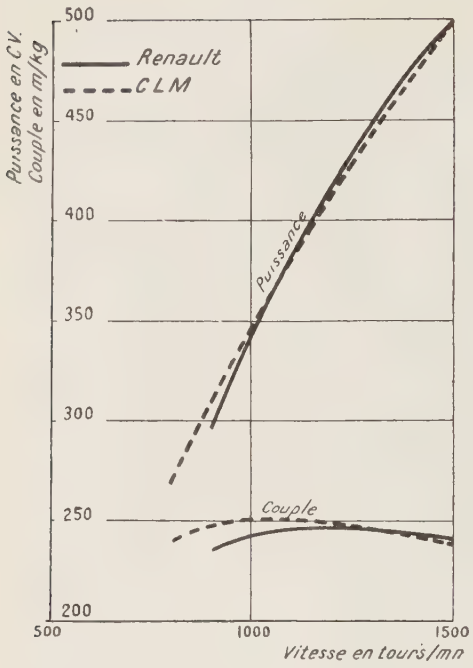


Cross section of 500-H.P. C.L.M. 8 DV 120 diesel engine.

liners, admission ports are arranged which are uncovered by the lower pistons, and, in the top part of the cylinder liners, there are exhaust ports which are uncovered by the upper pistons.

There is a slight lag in the passages of the upper and lower pistons at their dead centres, in order to ensure a convenient distribution, whilst preserving a very satisfactory balancing of the reciprocating parts.

The feed and scavenging air is suppli-



Horse-power and torque curves for the 500-H.P. Renault and C. L. M. engines.

Explanation of French terms :

Puissance en CV = horse-power. — Couple en m/kg = torque in kilogrammetres. — Vitesse en tours/min. = speed in r.p.m.

ed by a blower fan arranged at one end of the engine, and driven by one of the intermediate pinions, to which it is coupled by a flexible drive and a free wheel. At the nominal engine speed of 1 500 r. p. m., the blower runs at 19 000 r. p. m., and supplies air at the absolute pressure of 1.4 kgr./cm² (20 lb./sq. in.).

The engine casing, made of Alpax, is in three parts, namely :

A bottom case, containing the lower crankshaft;

A cylinder casting, in which are fitted the eight wet-type liners made of special cast iron, and which includes the scavenging air pipes in its bottom part;

A top case, containing the upper crankshaft.

These parts are assembled together by stud-bolts, and, in addition, robust tie-rods secure the caps of the crankshaft plummer blocks to the cylinder casting; these bearings are of lead-bronze.

The connecting rod ends are fitted with bearings made of lead-bronze, with the joint plane inclined, for the purpose of enabling the lower couplings to be withdrawn through the top of the engine, by passing through the cylinder liners.

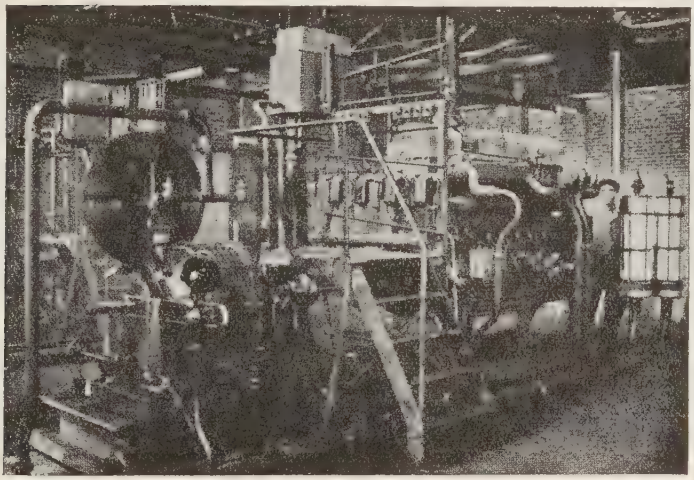
The pistons, which are made of a light alloy and the pin of which is mounted on needle bearings, are fitted with a detachable piston head made of special steel (valve steel), and six rings, one of which is a scraper ring.

Injection of the fuel is carried out by two sets of eight C. L. M. injector-pumps, which are arranged on either side of the engine, two for each cylinder, and are governed by a speed regulator. The advance injection is governed solely by the feed. Two cam shafts drive these injector-pumps through adjustable crank levers. All these parts are easy of access. The feed to the injector-pumps is ensured by a constant-level vessel, into which the fuel oil is fed after passing through the filters and a Perrier centrifugal separator.

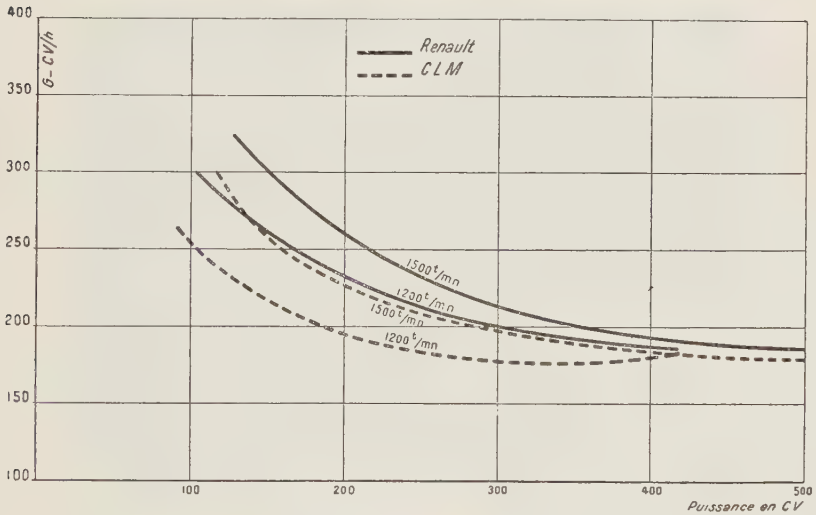
The lubricating oil is distributed to the motion by a gear-driven pump arranged in the bottom gearcase. A second pump, which is attached to the aforementioned pump, causes the oil to pass through a cooler, through which the engine cooling water circulates.

The first tests of the C. L. M. 500-H.P. engine took place from the 18th to the 21st July, 1938. The average consumption for the 72-hour endurance test, at the nominal horse-power of 500, and at the nominal speed of 1 500 r. p. m., was 175 gr. (0.385 lb.) per H.P.-hour of fuel oil, and 7 gr. (4 drams) per H.P.-hour of lubricating oil.

At the peak load, the engine developed, during one hour, 550 H.P. at 1 500 r. p. m., and, at the peak speed, 500 H.P. at 1 650 r. p. m., during one quarter of an hour. On being dismantled after the



500-H.P. 8 DV 120 C.L.M. engine on test bed.



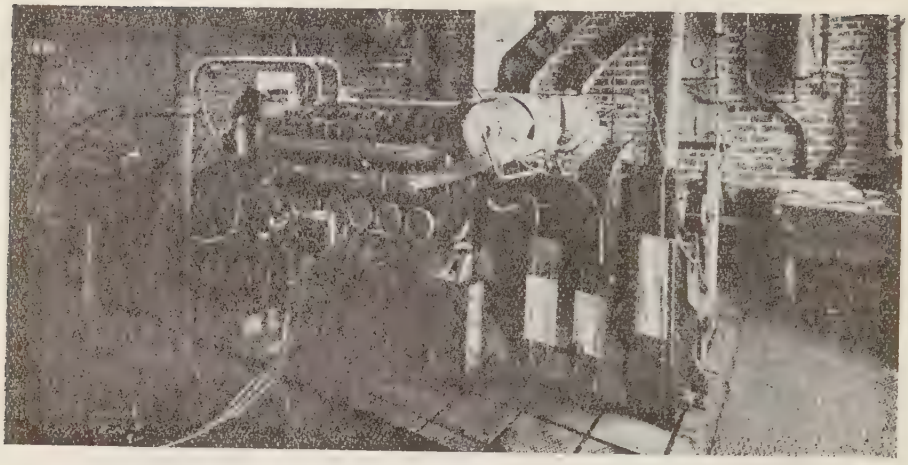
Consumption curves for the 500-H.P. Renault and C. L. M. engines.

test, the parts were found to be in satisfactory condition.

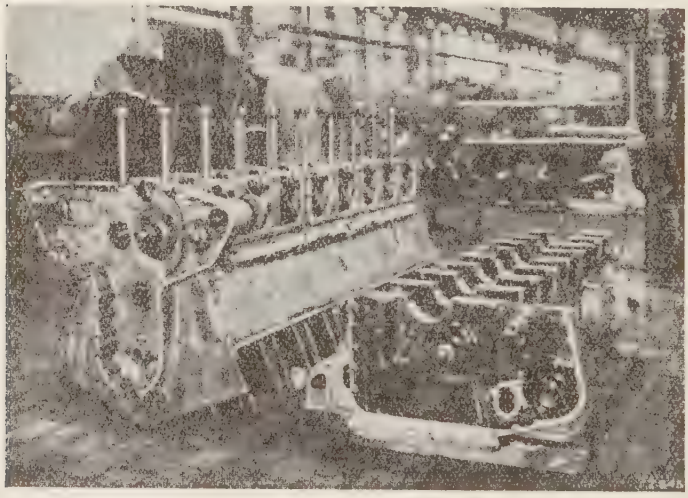
Supercharging tests of a Maybach 410-H.P. engine.

The fast motor trains of the Northern Region, the empty weight of which is 136 t. (133.8 Engl. tons), are equipped with two G 056 Maybach V-type engines, of a nominal horse-power of 410 [twelve cylinders, 160 mm. × 200 mm. (6 5/16" × 7 7/8")].

As this power was rather low for working express services with relatively frequent stops, or over lines in slightly



Supercharged 550-H.P. Maybach engine on test bed.



Cylinder block for the 500 H.P. Renault engine.

hilly country, supercharging by a turbo-blower driven by the exhaust gases was applied experimentally to one of these engines. The conversion was carried out by the « Société Franco-Belge de Matériel de Chemins de fer », with the close collaboration of the « Société Rateau », who also supplied the turbo-blowers.

The supercharging is effected by two Rateau turbo-blowers serving each of the cylinder lines.

The turbine distributor is divided in two sectors for air admission to the

cylinders, which are respectively connected, by distinct collectors, to two sets of three cylinders. At full load the turbo-blower runs at 15 000 r. p. m. and develops an absolute supercharging pressure of 0.32 kgr./cm² (4.55 lb./sq. in.). From May 30 to June 1, 1938, the supercharged engine successfully passed the 60-hour endurance tests at the nominal horse-power of 550. The peak power tests consisted in one hour's running at 575 h.p., and one quarter of an hour's running at 642 h.p. The average fuel oil consumption per h.p.-hour was 180 gr. (0.402 lb.), and the average lubricating oil consumption was 2.55 gr. (1.46 drams). On being dismantled, the parts of the engine were found to be in satisfactory condition.

Calculated on a nominal horse-power of 550, the weight of the supercharged engine is 3.9 kgr. (8.6 lb.) per h.p. as compared with 5.2 kgr. (11.5 lb.) prior to supercharging.

[625. 145.4 & 656. 256]

Recent developments in rail bonding

by W. P. BOVARD,

Manager, Rail Bond Division, Ohio Brass Company, Mansfield, Ohio.

(*Railway Signaling.*)

The short welded bond for installation on the rail head was introduced into the signal field in 1919, following its general use in railroad electrification. Advantages claimed for this type of bond included : Better broken-rail protection, low bonded rail resistance, and generally improved track circuit operation. Improvements through the ensuing years resulted in welded bonds of steel and of bronze construction, with much greater fatigue resistance.

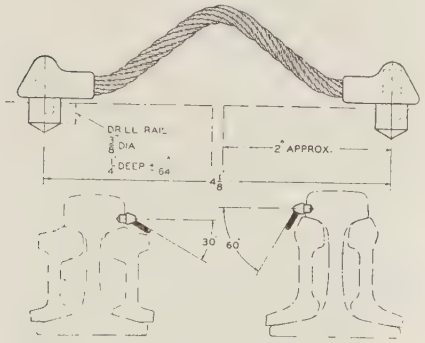


Fig. 1. — Two angles of strand assembly are provided in order that the bonds as applied to different types of rail and joint bars may fit snugly.

Fig. 2. — A machine with two drills, drills both holes simultaneously.

With the advent of the depression years, beginning in the early thirties, it became necessary to find methods of securing longer life for rail in main track, which heretofore had been retired to less important tracks, branch lines and sidings. Methods of oxy-acetylene and electric arc welding of battered and chipped ends were introduced, resulting in important economies due to improved running surface and to the postponement for years of the necessity of renewing the rail. Still later developments provided methods for heat treatment of the rail ends, thereby postponing the day when batter became a factor for additional expenditure.

A problem for signal engineers.

Introduction of these heat applications to rail developed new problems for the signal engineer, not only as a result of damage to the short bond on the rail head, but in damage to galvanize protection, annealing, and frequently actual fusion of long bonds spanning the joint and applied to the rail web. It was found that even an improved welded bond, which had been designed to withstand welding heat of application, and which, therefore, suffered less than any other type, suffered from some of the more severe welding processes. Although most roads apply rail welding and heat treatment methods over such bonds with a standard of care which enables the bonds to serve uniformly throughout the life of the rail, it was found necessary, on one road, because of particularly severe processes, to renew some 14 000 bonds due to actual fusion of the stranded body.

Meeting the challenge.

In order to make available to the signal field a bond which would meet these new conditions of rail heat applications regardless of the type of weld and

Fig. 3. — Bonds may be installed in pick-up maintenance with a hand drill.

Fig. 4. — Driving a bond with a 3-lb. hammer.

of the super-speed applications introduced, interest centered on the development of a bond which could be removed

Fig. 5. — Bond being removed with hammer and extractor tool.

and reliably reapplied after welding or heat treating operations, meanwhile retaining all of the advantages of the short welded bond previously mentioned. A short rail-head type of bond, with stud terminals which are applied directly into holes drilled in the head of the rail, was developed and used for this service.

Fig. 6. — A gas fired preheating furnace heats rail head to above 1 200° F. If the bond had not been removed this heat would be sufficient to anneal it and destroy a large part of its ability to serve.

Since abuses arising from the continual maintenance operations on the track and from ballast spreading and tamping operations are also factors which have a strong influence on rail bond performance, provision was made for maximum service under the most severe track conditions in selecting materials for the terminals and strands of the new bonds.

One type of bond which was finally evolved, because of lack of heat operation in manufacture or application, has been proved to have a laboratory service life 40 times that of its related welded bond after its normal welding operation. Since no such bond has been found which has failed due to fatigue in more than 10 years' service, it may reasonably be assumed that a remarkable advance has been made.

A standard of low bonded rail resistance was secured with the welded bond which was fractional as compared to the earlier methods. This desirable characteristic has been preserved in the newer type of bond with an installed resistance of 0.000 415 ohm. Two No. 8 EBB galvanized iron bond wires of 52 in. length installed will show a resistance of 0.005 210 ohm with joint plate contact neglected, a value of about 13 times the resistances of the short railhead bond. A maximum bonded track resistance of 0.04 ohm per 1 000 ft. of track is entirely practicable with the new mechanically applied railhead bond.

Since this new method of rail bonding involves installation in small drilled holes in the rail head, it is essential that accurately drilled holes be provided. Terminal plugs must be thoroughly tightened for mechanical reasons and to exclude all oxidation and possibility of progressive breakdown of electrical contact.

Twin-spindle drill developed.

Preparation of the rail head for the installation of the improved type of bond simply involves the drilling of two 3/8- in. diameter holes, spaced 4 1/8 in. and 1/4 in. depth (fig. 1).

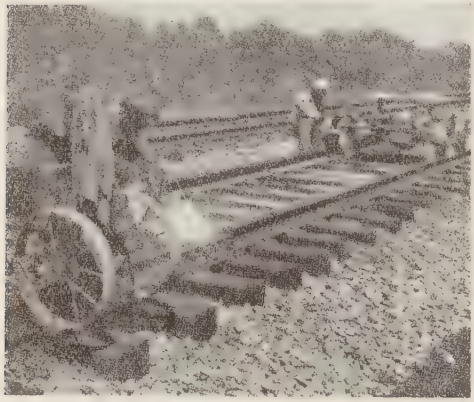


Fig. 7. — The welding operation — Note grinder finishing joint just previously welded.

In order to secure the maximum in drilling reliability and costs below other methods, a twin-spindle power drill has been developed, which will apply rail-head bonds at a lower cost than by other methods. The drilling time for the two holes, with the twin power drill, ranges upward from seven seconds in very soft rail with the usual drilling time about ten seconds. From 90 to 120 bonds per hour may be installed, thus insuring that a single bonding crew of two or three men and one twin drill may easily keep up with the fastest rail-laying crew. *Railway Signaling* for August, 1937, included two articles (page 447 and page 458) in which operation of the twin-spindle drill and other machines may be compared. Analysis of these articles will show that the twin-spindle type consumed 4 machine hours and 12 man hours per mile of bonded track, whereas single-spindle drills consumed 10-2/3 machine hours and 18-2/3 man hours for the same production. About one minute is required for each hole with a hand drill machine.

Methods of drill bit grinding were developed and are placed on a basis where great accuracy of drilling rail is secured. Annual savings in cost of drill bits alone of several hundred dollars have been secured during a normal year's rail-bonding program.

The bond, of course, may be installed with twin-spindle (fig. 2) or single-spindle power drills, or may be applied most efficiently in pick-up maintenance

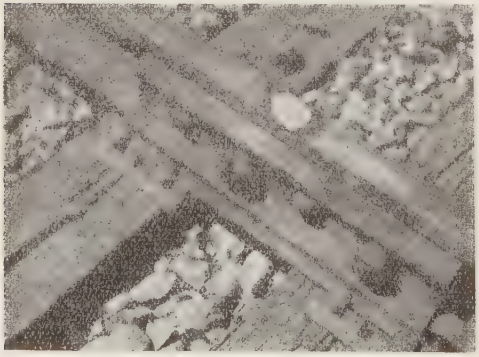


Fig. 8. — The rail end batter welded in readiness for grinding operations. Note bond holes.

Fig. 9. — The weld being surfaced with power grinder.

with hand drilling using the ordinary hand-operated signal bond drill with adaptation for railhead drilling (fig. 3). No limitations in installation are imposed by flange-worn surfaces of turned rail or rolled rail heads.

Fig. 10. — A finished joint with bond being reapplied. Because of heavily beaded joint a drift hammer is used.

Installing the new bonds.

The operation of installing the bond is that of driving the terminal with two or three sharp blows of a 3-lb. hammer (fig. 4). Where very heavily re-inforced joints are used or where double bonding is installed, some operators prefer to use a drift hammer which is placed against the bond terminal, and which receives the hammer blow.

After three years of commercial use, it is important to note that no inherent weaknesses or indicated inability to serve indefinitely have shown up in use on 37 railroads under every conceivable track and traffic condition.

Re-application.

In order to illustrate the practical adaptation of this method of bonding to rail heat treatment and welding operations, the reader is referred to the accompanying series of photographs (fig. 5 to fig. 10, inclusive) which will clearly explain the various steps in a rail repair program from removal of the bond to re-application after the joint is preheated, welded, ground and slotted.

With welding operations, the function of the signal department is usually to supply a man who removes the bonds ahead of the welding crew and makes re-application after the joints are repaired and cooled. Speed of the welding gang is such as to make it possible for one man to do this work. Because of the higher speed of heat treatment, two signal department men are usually required, one ahead and one back of the heat-treating gang.

Any joint bond which has undergone the exposure to heat of a joint weld is liable to be damaged. A practical solution for this difficult new problem, as described in the foregoing, removes the danger of early bond failures and resultant signal failures because of rail operations which are largely out of the control of the signal department.

[385 (093 (497.2)]

Fifty years of the Bulgarian State Railways [1] (1888-1938).

The railway line from the Serbian frontier to Caribrod-Sofia-Vakarel, 114 km. (70.8 miles) long, was inaugurated on the 5th Juli, 1888. This was the first line in Bulgaria built and directly operated by the State.

In 1938, the fiftieth anniversary of this important event in Bulgarian railway history was celebrated in Bulgaria, and the present article dealing with the Bulgarian Railways during the 1888-1938 period seems to be a fitting way of commemorating it.

I. — Introduction of State ownership of the railways in Bulgaria.

1. Proclamation of Bulgarian independence.

Article 1 of the Treaty of Berlin, 1878, made Northern Bulgaria and part of South-Western Bulgaria an independent principality under the suzerainty of the Sultan, while article 13 of the same Treaty made Eastern Bulgaria an autonomous State called East Roumelia, under the political authority of the Sultan.

For various reasons, but mainly for national and financial ones, this artificial division of Bulgaria into two States only lasted a short while. On the 18th September, 1885, following a pronunciamento, the government of East Roumelia was dissolved and the two regions were made into a single principality known as Bulgaria. This amalgamation was sanctioned by the Great Powers and Turkey by the Agreement of the 5th April, 1886.

The principality of Bulgaria, proclaimed on the 18th September, 1885, remained under the suzerainty of the Sultan until the 5th October, 1908, when the Bulgarian Government issued a proclamation changing the political *régime* of the principality into an independent kingdom under the name of « Tzarstvo Bulgaria ». A treaty was signed on the 19th April, 1909, by which (Article 8), Turkey recognised the new political situation in Bulgaria, brought about by the above mentioned Act of the 5th October, 1908.

2. Bulgaria's international obligations regarding its railways.

It is only necessary to mention here the international obligations concerning:

(*a*) the railway lines built and opened to traffic before 1878, towards the middle of which year the Principality of Bulgaria and East Roumelia were constituted by the Treaty of Berlin;

(*b*) the completion of a few railway lines begun prior to 1878, and their linking up with the lines of neighbouring States.

In 1878, the only railway line in the Principality of Bulgaria was the standard-gauge line from Roussé (port on the Danube) to Varna (port on the Black Sea), some 223 km. (138.6 miles) long. This line was built by an English Company with a 99-year concession, and was opened to traffic in 1866. According to article 10 of the Treaty of Berlin, the Principality of Bulgaria took over the

(1) We are indebted to the General Management of the Bulgarian State Railways and Harbours for the information contained in this note.

obligations of Turkey towards this Company. The chief of these obligations was an annual payment to the Company of £ 140 000 sterling, representing 7 % interest on the Company's nominal capital of £ 2 000 000 sterling.

In 1878 there were 310 km. (192.6 miles) of standard-gauge line in East Roumelia, operated by a foreign company, viz : (*a*) the Bélovo-Lioubimetz-Turkish frontier line, 204 km. (126.8 miles) long, opened to traffic in 1873, which was a section of the international main line from Vienna to Constantinople, and (*b*) the Zlatidol-Yambol line, 106 km. (65.8 miles) long, opened to traffic in 1874, which formed part of the inland main line from the Black Sea port of Bourgas. In article 21 of the Treaty of Berlin, it was laid down that the rights and obligations of Turkey in connection with the railway lines in East Roumelia were to remain unaltered. By 1878 Turkey had only carried out an insignificant amount of work in connection with the construction of the above-mentioned section of the international line west of Bélovo, a section which Turkey had promised Austria to complete and join up with lines in neighbouring countries. By article 10 of the Treaty of Berlin, Bulgaria had to take over Turkey's obligations to complete this section and link it up with the international line crossing the Principality.

3. Law of 1885 introducing State ownership of the railways into Bulgaria.

To meet the above-mentioned obligations as regards the completion of the Bulgarian section of the international line from Vienna to Constantinople, as well as to satisfy the frequent demands of the English Company that the Roussé-Varna line be purchased from them, the authorities during the first few years of the new State had to decide an important problem : What system of railway ownership was to be adopted ?

After very thorough investigations and deliberations, a law was passed in 1885, with the following fundamental clauses : the railways of the Principality are the property of the State which operates them itself; no company or private individual has the right to build or operate any railway line in the Principality, except as regards private sidings at mines, in works and other business premises.

These fundamental provisions clearly and quite categorically prove that the law of 1885 introduced State ownership of the railways. This was done chiefly to make the railway one of the leading factors in the development of Bulgaria.

4. First State railway line in Bulgaria.

Immediately after the promulgation of the above law of 1885, work began on the construction of the railway line from the Serbian frontier to Caribrod-Sofia-Vakarel (114 km. = 70.8 miles), forming part of the international line from Vienna to Constantinople, which ran through the Principality.

The reunion proclaimed in the 1885 autumn and the war with Serbia which was one of the results, considerably delayed the completion of this line — the first State railway line in Bulgaria. As a result of these events, the Serbian frontier-Caribrod-Sofia-Vakarel line was only opened to local traffic on the 5th July, 1888, and this date is taken as the beginning of the Bulgarian State Railways. The line was only opened to international traffic a few weeks later, owing to the difficulty of putting the Vakarel-Bélovo line into operation, as this ran through former East Roumelia territory.

According to article 21 of the Treaty of Berlin, the construction of the Vakarel-Bélovo line was one of Turkey's obligations, not East Roumelia's. To meet this obligation, at the beginning of 1885 Turkey gave out the contract for the building of the Vakarel-Bélovo line,

46 km. (28.6 miles) long, to the foreign Vitalis Company. The same article of the Treaty of Berlin remained in force even after the reunion of the Principality of Bulgaria and East Roumelia in 1885, and therefore the Vitalis Company continued to build the line, completed it about the middle of 1888, and received from Turkey the agreed sum for this work.

According to an agreement made in 1872, Turkey had to hand over the operation of the Vakarel-Bélovo line to the Company working the railways in Turkey in Europe, which also operated the lines in East Roumelia, a total length of 310 km. (192.6 miles). Owing to litigation between this Company and Turkey, this country refused to hand over the operation of the Vakarel-Bélovo line to the said company and entrusted this to the Vitalis Company which had built it. The Bulgarian Government protested to the Turkish Government about this introduction of a second Company to operate lines in former East Roumelia territory, which was not based on any international agreement. At the same time the Bulgarian Government suggested that the Turkish Government should hand over to Bulgaria the operation of the Vakarel-Bélovo line in order not to impede the service on the Bulgarian section of the international Vienna-Constantinople line. The Turkish Government would not accept this proposal. As agreement seemed unlikely to be reached in the near future, the Bulgarian Government took possession of the Vakarel-Bélovo line on the 15th July 1888 and began to operate it with the aid of the staff of the first Bulgarian State line which had been opened to local traffic a short time previously.

This unilateral act enabled Bulgaria to hasten the putting into operation of the whole of the line from Vienna to Constantinople, which was opened to traffic on the 1st August, 1888.

In the case of the Vakarel-Bélovo line, the dispute between Bulgaria and Turkey was only settled in 1894, when Bulgaria agreed to rent this line from Turkey as from the date of occupation in 1888. This rent was paid by Bulgaria until the proclamation of an independent Bulgarian Kingdom on the 5th October 1908, when it was agreed that the Vakarel-Bélovo line, built by Turkey, became the property of the Bulgarian State.

5. Purchase of private Bulgarian lines.

As regards the introduction of State ownership of the railways in Bulgaria, the first step was to construct and open to traffic the line from the Serbian frontier to Caribrod-Vakarel; the second was the occupation and opening to traffic of the Vakarel-Bélovo line; and finally the third step was the purchase of the private railways mentioned in Chapter 2 above, a total of 533 km. (331.2 miles) of line.

As the English Company working the Roussé-Varna line wanted to wind up this undertaking, the results of which had come far short of expectations, soon after the proclamation of the Principality of Bulgaria, conversations were begun about the purchase of this private line. These lasted several years, as the Company asked a price of 50 million gold-francs, a sum equal to the nominal capital of the Company. Now according to the valuations of foreign experts, the Company had spent at the most 20 million gold-francs on the construction of the line and the rolling stock. Bulgaria, however, was in a very unfavourable political situation during the years 1885-1886, so that the Government was obliged to agree to a purchase price of 50 million gold-francs.

In 1886 the regular revenue of the Bulgarian State was some 49 million gold-francs, so that the purchase price of 50 million francs could only be met by borrowing the money from abroad. It was, therefore, in order to purchase

the Roussé-Varna line that Bulgaria first approached Great Britain for a loan of 47 million gold-francs, in 1886. The loan was only granted in 1888, and owing to this delay, 3 million gold-francs were added to the sum quoted above for interest and other amounts due to the English Company. Consequently it cost Bulgaria 53 million gold-francs to purchase the Roussé-Varna line, 6 million in species and 47 million in shares in the first State loan.

After the Serbian frontier-Caribrod-Bélovo line was opened to traffic in 1888, and the Yambol-Bourgas line in 1890, the Bulgarian Government wished to purchase the private lines in former East Roumelian territory in order to have a State system linking up the interior of Southern Bulgaria with Bourgas, the chief port on the Black Sea. These private lines, however, formed the best part of a railway network operated by a foreign company under the chairmanship of Baron Hirsch. In addition, in spite of the reunion of 1885, article 21 of the Treaty of Berlin still remained in force, so that the rights of Turkey over the private lines in the former State of East Roumelia remained intact. In view of these circumstances, the Bulgarian Government had to await a favourable opportunity to purchase the lines in question. This occurred in the Autumn of 1908, when the staff of these lines went on strike for higher wages. This strike interrupted the traffic on all the private lines in South Bulgaria, and the traffic between the capital, Sofia, and the port of Bourgas. As it seemed likely to last indefinitely, on the 22nd September, 1908, the Bulgarian Government took possession of the private railways in South Bulgaria for State reasons and opened them to traffic again with the aid of the State Railways' staff, which already operated some 1 200 km. (746 miles) of line. The occupation of the private lines in South Bulgaria was followed by the proclamation of the independence of the Bulgarian Kingdom on the 5th October, 1908. In connection with the regularisation of this event, the Bulgarian Government expressed its desire to purchase the private lines it had taken possession of. After very difficult negociations, towards the middle of 1909 the purchase price was agreed at 42 million French francs. This sum was paid by means of part of a loan of 82 million French francs concluded at the same time with Russia to regulate the financial consequences of the proclamation of the independence of the Kingdom of Bulgaria.

It was agreed that the purchase of the private lines in question was to take effect as from the date at which the Government took possession of them. After this purchase there were no further private lines in Bulgaria, so that the *22nd September 1908* may be taken as the date of the definite introduction of State ownership of the railways in Bulgaria. Consequently from 1909 the development of the Bulgarian State Railways represents that of the entire railway system in Bulgaria.

The great advantages of State ownership which are universally admitted have also been appreciated in Bulgaria. For this reason, even in the bad years after the 1915-1918 war, there has never been any question of modifying the Bulgarian State Railway ownership, which was made legal in 1885, and became an actual fact in 1908.

II. — Growth of the Bulgarian State Railway system.

1. Standard-gauge main lines.

From what precedes it will be seen that towards the end of 1888, the first year of the Bulgarian State Rys., there were 383 km. (238 miles) of standard-gauge lines in operation, viz: the Roussé-Varna line, 223 km. (138.6 miles) long, and the line from the Serbian frontier to Caribroad-Sofia-Bélovo, 160 km. (99.4 miles) long.

The latter was part of the international line from Vienna to Constantinople through Bulgaria, while the other part, the Bélovo-Plovdiv-Lioubimetz-Turkish frontier private line (204 km. = 126.8 miles) was purchased towards the end of 1908. At this date the whole line from the Serbian frontier to the Turkish frontier via Caribrod-Sofia-Plovdiv-Lioubimetz (364 km. = 226.2 miles), i. e. the Bulgarian section of the international line in question, became the property of the State. As a result of the territorial changes due to the Great War, this Bulgarian main line was cut short by 10 km. (6.2 miles) ceded to Jugoslavia, and lengthened by 6 km. (3.7 miles) bought from the private railways of Turkey in Europe. At the present time the Bulgarian section of the international Vienna-Constantinople line : Jugoslavian frontier - Dragoman - Sofia-Plovdiv-Svilengrade-Turkish frontier, is 360 km. (223.7 miles) long.

Towards the Black Sea, the terminus station of the private lines was Yambol, a bare 110 km. (68.3 miles) from Bourgas, the chief Southern Bulgarian port on the Black Sea. For this reason, soon after the inauguration of the Bulgarian section of the international Vienna-Constantinople line, the Yambol-Bourgas main line was built; it was opened to traffic in 1890. Thanks to this line, all South Bulgaria and part of West Bulgaria (including the capital, Sofia) were linked by rail to Bourgas with, however, a detour via Zlatidol. To avoid this detour, after purchasing the private lines in South Bulgaria, the Plovdiv-Nova-Zagora section was built, and opened to traffic in 1910. This section completed the Plovdiv-Bourgas through line, 294 km. (182.7 miles) long, the chief line in the South.

The Roussé-Varna main line links up a very small portion of North Bulgaria with Varna (the chief Black Sea port). To connect this port with North Bulgaria and the capital, Sofia, in 1894 the construction of the longest main line was begun : Sofia-G. Orehovitza-Kaspitchan (station on the Roussé-Varna line), 458 km. (284.6 miles) long. This new line was opened to traffic in 1899, and completed the North main line, Sofia-G. Orehovitza-Kaspitchan-Varna, 541 km. (336.2 miles) long. As a result this main line includes the Kaspitchan-Varna section (83 km. = 51.6 miles) of the Roussé-Varna line, of which the part that remained over after the North main line was opened to traffic, is a separate main line : Kaspitchan-Roussé, 140 km. (87 miles) long.

The first section (Sofia-Pernik) of the South-West Sofia-Güéchévo main line (136 km. = 84.5 miles long), was built above all to supply the Bulgarian lines with native coal — from the largest mine in Bulgaria near Pernik — and is only 35 km. (21.7 miles) long. This section was opened to traffic in 1893, whereas the other part of this Sofia-Güéchévo line was only opened to traffic in 1910. During the World War, a 60-cm. (1 ft. 11 5/8 in.) gauge line was built from Radomir station on this line to Petrich. Between 1930 and 1937 the Radomir-Gorna-Djoumaya narrow-gauge section (72 km. = 44.7 miles) was replaced by a standard-gauge section, this branching off the South-West main line.

When the North main line was opened to traffic, communication was established between North and South Bulgaria, but with a detour via Sofia. To link up these two parts of the country directly, the trans-Balkan line from Roussé (chief port on the Danube) to G. Orehovitza (one of the stations on the North main line) and St. Zagora (one of the stations on the South line) was begun in 1897. This trans-Balkan line, 265 km. (164.7 miles) long, was opened to traffic in 1913.

In 1908 the North-West main line was begun : Mezdra (station 88 km. = 54.7 miles from Sofia on the North main line) to Lom (port on the Danube). This main line, 118 km. (73.3 miles) long, was opened to traffic in 1913.

In 1897 the Nort-East main line was begun, from Iovkovo (station on the North main line near Varna) to Oborichte on the Rumanian frontier. This 51-km. (31.6 miles) long main line was opened to traffic in 1910. By means of this line through rail communication between Bulgaria and Rumania was made possible in 1913.

As a result of all this, on the fiftieth anniversary of the Bulgarian State Rys. 1 977 km. (1 224.5 miles) of main lines are in operation. The greater part of the main lines being now completed, only a few hundred miles of main lines remain to be built in order to complete and improve the system and make new connections with the railways in neighbouring States.

2. Other standard gauge lines.

After completing a few main lines, and perfecting the other lines of the same category, 933 km. (579.7 miles) of secondary standard-gauge lines linking up the main lines to the interior of the country and the Danubian ports had been built and opened to traffic up to the end of 1937.

3. Narrow-gauge railway lines.

In view of the part played by the railway as the chief factor in a country's progress, all the lines built in Bulgaria up to the time of the 1914-1918 War were standard gauge lines. During the 1915-1918 period however, for military reasons, 353 km. (219.3 miles) of narrow-gauge lines were built and opened to traffic, 50 km. (31 miles) being 76-cm. (2 ft. 5 7/8 in.) gauge and the remainder, 303 km. (188.3 miles) 60-cm. (1 ft. 11 5/8 in.) gauge.

The operating results for the narrow-gauge lines were poor, especially when the above-mentioned role of the railway is borne in mind. For this reason the tendency is to replace most of the 60-cm. gauge lines by standard-gauge lines. At the end of 1937 there were 434 km. (269.7 miles) of narrow-gauge lines in Bulgaria, 228 km. (141.7 miles) being 60-cm. gauge and 206 km. (128 miles) 76-cm. gauge.

4. The railway system.

The development of the standard and narrow-gauge railway system in Bulgaria can be summed up as follows :

Railway lines.	*At the end of the year :*									
	1878		1888		1908		1918		1937	
State lines :	Km.	*Miles*	Km.	*Miles*	Km.	*Miles*	Km.	*Miles*	Km.	*Miles*
Main standard-gauge lines	—	—	383(*)	*238*(*)	1 338	*831*	1 909	*1 186*	1 977	*1 228*
Other standard-gauge lines	—	—	—	—	251	*156*	294	*183*	933	*580*
Narrow-gauge lines .	—	—	—	—	—	—	353	*219*	454	*282*
Total State lines . .	—	—	383	*238*	1 589	*987*	2 556	*1 588*	3 364	*2 090*
Total private lines .	533	*331*	310	*193*	—	—	—	—	—	—
General total . . .	533	*331*	693	*431*	1 589	*987*	2 556	*1 588*	3 364(†)	*2 090*(†)

This shows that the railway system has increased sixfold between 1878 and

(*) Including the Vakarel-Bélovo line, 46 km. (28.6 miles) long.

(†) All these lines are single-track, with steam traction.

1937. As in other countries, this growth has not gone on continuously, as the following information shows :

Period.		Growth of the system : Total.	Yearly average.
1878-1888	Km.	160	16
	Miles	*100*	*10*
1889-1908	Km.	896	43
	Miles	*557*	*27*
1909-1918	Km.	967 (614***)	97 (62***)
	Miles	*600 (381***)*	*60 (38***)*
1919-1937	Km.	788 (707***)	41 (37***)
	Miles	*490 (439***)*	*25 (23***)*

The greatest annual average increase was between 1909 and 1918, during which period 506 km. (314 miles) of main line were built and most of the narrow-gauge lines.

As there have been no important territorial changes between 1878 and 1937, this considerable increase in the length of the system has had a proportional effect on its density, as the following table shows :

At the end of the year	Length of the system Km. (Miles).	Territory. Km² (Sq. miles).	Miles of line per 1 000 sq. miles.
1878	533	96 346	5.5
	(331)	*(37 199)*	
1888	693	96 346	7.2
	(431)	*(37 199)*	
1908	1 589	96 346	16.5
	(987)	*(37 199)*	
1918	2 556	103 146	24.8
	(1 588)	*(39 825)*	
1937	3 364	103 146	32.4
	(2 090)	*(39 825)*	

The figures given in the last column show that between 1878 and 1937 the density of the system has increased six-fold. During the same period the population of Bulgaria has greatly increased as well. The ratio of the length of the system to the population figures is given in the last column of the following table:

At the end of the year.	Length of the system Km. (Miles).	Population (thousands).	Km. (Miles). of railway per 10 000 inhabitants.
1878	533	2 450	21.8
	(331)		*(13.5)*
1888	693	3 185	21.8
	(431)		*(13.5)*
1908	1 589	4 214	37.7
	(987)		*(23.4)*
1918	2 556	5 076	50.4
	(1 558)		*(31.3)*
1937	3 364	6 238	53.6
	(2 090)		*(33.3)*

The above table shows the great progress Bulgaria has made in increasing the length of her railway system and its density. It is as well to point out the relative value of this progress, however. The results obtained by Bulgaria should be compared with those in neighbouring countries, such as Rumania and Jugoslavia. The following information relates to the year 1936 :

Countries.	Lines in operation. Per 1 000 km²	(Per 1 000 sq. miles)	Per 100 000 inhabitants. Km.	(Miles)
Rumania	40	*(104)*	60	*(37.3)*
Jugoslavia	38	*(98)*	62	*(38.5)*
Bulgaria	32	*(74)*	52	*(32.3)*

This shows that as far as the density of the system is concerned, Bulgaria is in a less favourable position than Rumania or Jugoslavia. This is due above all to the financial difficulties experienced in completing 600 km. (373 miles) of new lines, the construction of which was started a long time ago.

The appended map of the Bulgarian State Railways shows the lines in operation and those under construction towards the end of 1937. Those shown by a heavy line between two lines are those in operation at the end of 1888 — the first year of the Bulgarian State Railways.

(***) Only in the case of standard-gauge lines.

Map of the Bulgarian Rys.

EXPLANATION :

Lines in operation :

Standard gauge . . . . . ▬▬▬▬

76-cm. (2 ft. 5 7/8 in.) gauge . ——————

60-cm. (1 ft. 11 5/8 in.) gauge . ——————

Lines under construction :

Standard gauge ▬▬▬▬

Narrow gauge - - - - - - - - - - - -

5. Linking up the Bulgarian State Railways with lines in adjoining countries.

In view of the geographical situation of Bulgaria, the first line owned by the State, as we said earlier on, was built as part of the international line from Vienna to Constantinople. When this line was opened to traffic during 1888, the Bulgarian system was linked up thereby with that of Serbia (in the west) and Turkey in Europe (in the east). As a result of the repurchase of the private lines in South Bulgaria and the territorial changes resulting from the 1914-1918 War, the junction of the Bulgarian system with that of Jugoslavia occurs on the frontier near the Dragoman station on the Vienna-Constantinople international line, and the junction with Turkey on the frontier near Svilengrade station on the same international line.

Owing to unfavourable political circumstances, after this linking up with the Jugoslavian and Turkish systems in the first year of the State Railways' existence, no further junction with any other country took place except with Rumania on the Iovkovo-Oborichte-Rumanian frontier main line in 1913. This is not so important, however, as it takes place in the north-eastern corner of Bulgaria.

If the Bulgarian and Rumanian railways could be linked up by a bridge across the Danube, this would be of capital importance. The two Governments have exchanged views on this matter on several occasions; the first time, as far back as 1881, the exact site of the bridge was even discussed. Up till 1937, however, the only agreement reached has been the introduction of a ferry-boat service between Roussé and Guiourguevo, to be put into service during 1939, thus giving a through, but imperfect, connection between the Bulgarian and Rumanian systems.

The favourable results of this linking up would be an argument for joining up the Bulgarian system with the Greek railways by extending the Bulgarian Roussé - St. Zagora - Rakovsty - Momtchilgrad line as far as the corresponding Greek line to be built in Thrace.

III. — Rolling stock.

The information given above about the growth of the Bulgarian railway system shows that, towards the end of the year 1937, the narrow-gauge lines formed 13 % of the total system, having been extended as a result of the 1914-1918 War. We would like to point out, however, that the volume of traffic on the narrow-gauge system only represents 3 % of the total traffic. This part of our article will therefore only deal with the rolling stock used on the standard-gauge lines of the Bulgarian State Rys.

1. Locomotives.

In 1888 the Roussé-Varna private line was purchased together with its 13 locomotives, 9 of which were built by an English firm in 1866, and the other 4 by a Viennese firm in 1883; in 1888 the same firm built 14 locomotives for the first line of the Bulgarian State Rys. As a result, in 1888 — the first year of their existence — the Bulgarian State Rys. owned 27 locomotives. As the system was extended and the traffic increased, the stock of locomotives was added to, as the following figures show :

	1889	*1909*	*1937*
Total stock of locomotives.	27	155	480
Number of locomotives per 100 km. *(per 100 miles)* of line.	7 *(11)*	9 *(14)*	17 *(27)*
Volume of traffic in millions of units per locomotive	0.7	2.5	3

1889 was the first complete working year of the Bulgarian State Rys., and 1909 was the first complete working year after State ownership of the railways had been completed in Bulgaria.

During the 50 years the railways have

been in operation, the stock of locomotives (including those taken over with the private lines) has increased to 551, nearly all built by German firms. During the same period, 71 locomotives have been scrapped, and towards the end of the period, the Bulgarian railways owned 480 locomotives. The number of locomotives in service has been multiplied by 18, and the length of line in operation by 7 1/2 (so that the average number of locomotives per 100 miles of line has increased by 2 1/2).

This increased proportion of locomotives is a function of the corresponding fluctuations in the volume of traffic, expressed as the number of passenger-miles plus the ton-miles per mile of line operated. During the 50 years in question, this volume has increased in the proportion of 1 to 9, i. e., 4 times more than the relative number of locomotives, as during the same period the volume of traffic per locomotive has increased fourfold.

The increase in the relative volume of traffic is due to the great general progress made in the construction of steam locomotives, and taken advantage of in the construction of the Bulgarian steam locomotives. As a result the increase in the number of locomotives has gone hand in hand with an appreciable increase in the efficiency of the locomotives. The chief characteristics of this progressive development are shown in the following table :

Year built.	*Type.*	*Heating surface. M² (Sq. ft.)*	*Maximum hourly speed. Km. (Miles)*	*Tractive effort in cylinders. Kgr. (Lb.)*	*Adhesion weight. Kgr. (Lb.)*	*Horse-power.*
1886	0- 6-0	93 *(1 001)*	50 *(31.0)*	4 200 *(9 259)*	5 000 *(11 020)*	230
1891	0- 8-0	178 *(1 916)*	45 *(28.0)*	8 950 *(19 730)*	9 000 *(19 840)*	540
1896	0- 6-0	114 *(1 227)*	50 *(31.0)*	5 950 *(13 120)*	6 750 *(14 880)*	330
1904	0- 8-0	158 *(1 700)*	45 *(28.0)*	9 050 *(19 950)*	9 400 *(20 720)*	470
1905	4- 6-0	165 *(1 776)*	90 *(56.0)*	7 240 *(15 960)*	7 100 *(15 650)*	480
1909	0-10-0	210 *(2 260)*	50 *(31.0)*	13 300 *(29 320)*	11 300 *(24 910)*	740
1913	2- 8-0	227 *(2 443)*	80 *(50.0)*	11 300 *(24 910)*	9 500 *(20 940)*	780
1913	2- 5-0	252 *(2 712)*	55 *(34.2)*	15 100 *(33 290)*	11 700 *(25 790)*	920
1922	0-12-0	252 *(2 712)*	45 *(28.0)*	15 700 *(34 610)*	15 500 *(34 170)*	870
1931	2- 8-2	308 *(3 315)*	90 *(56.0)*	16 600 *(36 600)*	12 270 *(27 050)*	1 300
1931	2-10-0	308 *(3 315)*	75 *(46.6)*	21 400 *(47 180)*	15 500 *(34 170)*	1 340
1931	2-12-4	308 *(3 315)*	65 *(40.4)*	24 500 *(54 010)*	17 000 *(37 480)*	1 370

To bring out clearly the progress made in the construction of the Bulgarian locomotives, Figures 1 and 2 show one of the most recent locomotives, and one built in 1866. The latter is very well preserved and will be put in the proposed Railway Museum.

2. Railcars.

A 50-h.p. steam railcar was supplied in 1905, an 80-h.p. car in 1907, and three additional 80-h.p. cars in 1908. These 5 railcars were four-wheelers with 40 third-class seats, and their average tare was 475 kgr. (1 047 lb.) per seat. The operating results with these 5 railcars were unsatisfactory, so that in the end they were converted into passenger coaches.

In 1935, a four-wheeled railcar was bought with a 120-h.p. diesel engine and mechanical drive, a maximum speed of 60 km. (37.3 miles) an hour, 60 third-class seats, and an average tare of 342 kgr. (754 lb.) per seat.

In 1936, three further four-wheeled railcars were bought with 150-h.p. diesel engines and electric drive; maximum speed 80 km. (50 miles) an hour; 56 third-class seats; average tare 389 kgr. (858 lb.) per seat.

Towards the end of 1937, the Bulgarian State Rys. therefore had four railcars, all four-wheelers. The usefulness of increasing the railcar stock is recognised in Bulgaria, but has to be sub-

Fig. 1. — *Left :* Locomotive built in 1931.
Right : Locomotive built in 1866.

ordinated to the financial situation of the railway.

3. Passenger coaches.

In 1888, the Roussé-Varna private line was purchased together with its 43 passenger coaches, all built in 1866 by a Belgian firm.

Amongst this stock was a six-wheeled drawing-room car used by the Empress Eugénie, of France, on her return from a visit to the Sultan in Constantinople, by Prince Rudolph, heir presumptive of Austria, by the Turkish Sultan Abdul-Aziz, by Princess Clémentine, the Mother of King Ferdinand of Bulgaria, and by the present King-Emperor of Italy when heir presumptive. In addition to its historical interest, the said car has certain interesting constructional features, as can be seen from Figs. 3 and 4. This drawing-room car is also very well preserved and is to be put in the Bulgarian Railways' Museum.

All the other passenger coaches of the Roussé-Varna line were four-wheelers and have long since been taken out of service owing to their imperfect design : no lavatories, and no heating in the thirds, and very primitive heating in the second and first class carriages by means of metal containers which were filled with hot water, but soon got cold.

In 1888, a German firm supplied 49 passenger coaches for the first Bulgarian State Railway line. Amongst these was a drawing-room car with two four-wheeled bogies, the first vehicle of this type owned by the Bulgarian Rys. Its dimensions are shown in Fig. 5. The

Fig. 2. — *In the foreground :* Locomotive built in 1866.
In the background : Locomotive built in 1931.

coaches bought in 1888 were a great improvement on the coaches of the private Roussé-Varna line; they had three pairs of wheels and were of much stronger construction; they were also fitted with lavatories and heating by means of briquettes.

In the following years, owing to the increased mileage of the system, and the amount of passenger traffic, the number of coaches was increased, as the following figures show :

	1889	*1909*	*1937*
Total number of passenger coaches . .	92	226	553
Total number of seats	3 438	9 622	31 729
Thousands of passenger-km. *(of passenger-miles)* per seat available	3 *(1.8)*	20 *(12.4)*	21 *(13)*

This shows that during the fifty years in question the number of passenger coaches increased in the ratio of 1 to 6, and the number of seats available in the ratio of 1 to 9, i. e. the stock of coaches was increased by larger-capacity vehicles. When increasing the number of passenger coaches on the Bulgarian State Rys., full advantage was taken of the great progress made in the construction of such stock, but at the same time the tare increased from 283 kgr. (624 lb.) per seat in 1888 to 411 kgr. (906 lb.) in 1937. Thanks to these improvements, the present day Bulgarian coaches (most of which were built by German firms) are the equal of those of other European railways.

This information also shows that during this period the average traffic per

Fig. 3. — Drawing-room car with three pairs of wheels, built in 1866.

seat increased in the ratio of 1 to 7. This favourable result is due above all to the considerable increase in the amount of passenger traffic, the appreciable increase in the mileage of the passenger stock, and a better utilization of the capacity of the vehicles.

4. Goods wagons.

In 1888, the Roussé-Varna private line was purchased together with its 422 goods wagons, all of which were built by a Belgian firm in 1866, and were four-wheeled vehicles with a capacity of 8 tonnes in the case of the covered wagons, and 5 tonnes in the case of the open wagons. In 1888, a German firm supplied 205 wagons for use on the first State railway line in Bulgaria. These also were four-wheelers, but the capacity was 10 tonnes, and they were of much stronger construction than the wagons on the Roussé-Varna line. During the period under review, as a result of the increased mileage of the standard-gauge lines of the system and the increasing volume of goods traffic, the number of goods wagons was increased as shown by the following figures :

	1889	*1909*	*1937*
Total number of goods wagons . .	627	3 387	9 500
Total capacity in tonnes	5 619	44 789	154 987
Average capacity per wagon in tonnes	8.9	13.2	16.0
Thousands of tonne-km. per tonne *(of ton-miles per Engl. ton)* capacity	2 *(1.25)*	4 *(2.5)*	5 *(3.1)*

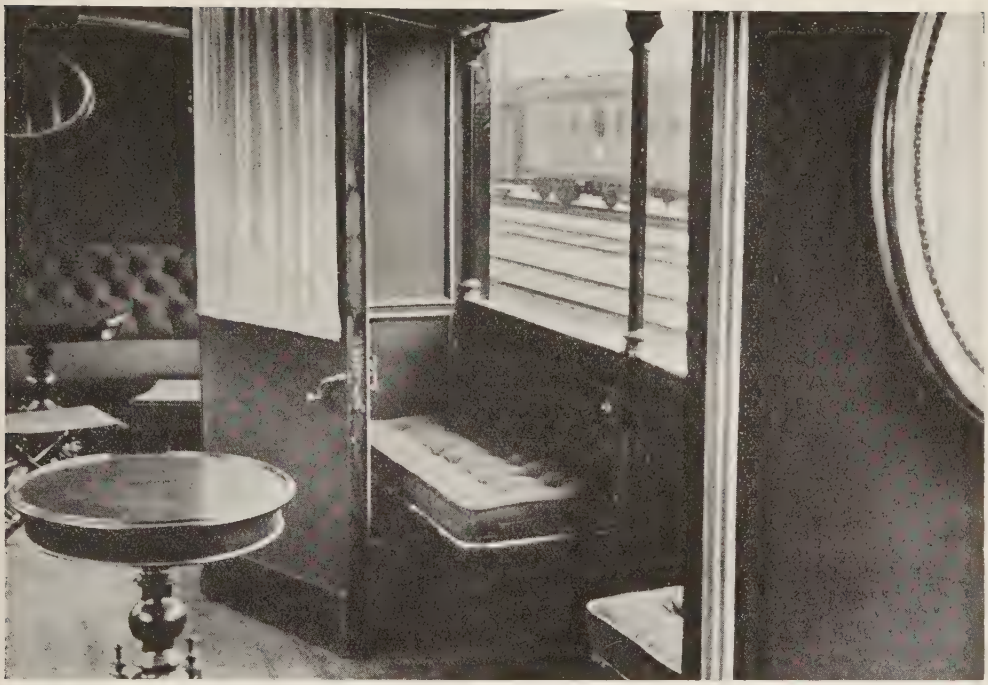


Fig. 4. — Interior view of the drawing-room car, built in 1866.

These figures show that during the period in question the stock of goods wagons increased in the ratio of 1 to 16, and their loading capacity in the ratio of 1 to 28, as vehicles of greater capacity were purchased and the average load increased by 80 %. As the stock of goods wagons was increased, the Bulgarian State Rys. profited by the great progress made in the construction of such stock, so that at the present time the goods wagons (most of which have been built by German firms) have all the qualities of those used on other European railways.

The same figures also show that during the period under review, the volume of traffic per tonne capacity has increased in the ratio of 1 to 2 1/2. This favourable evolution is due above all to the increased loading capacity and the higher mileage of the goods wagons, as well as the increasing density of the goods traffic.

IV. — Government control, administration and staff of the railway.

1. Government control.

According to the Constitution of the State of Bulgaria, Government control of the railways during the period of 50 years under review has been exercised by the National Assembly, the Head of the State, the Council of Ministers, and in particular the Ministry of Railways. Each of these Authorities of the State Government has carried out the duties allotted to it by the Constitution, as regards the State Railways.

As a result of the reforms introduced during the period in question, dealing

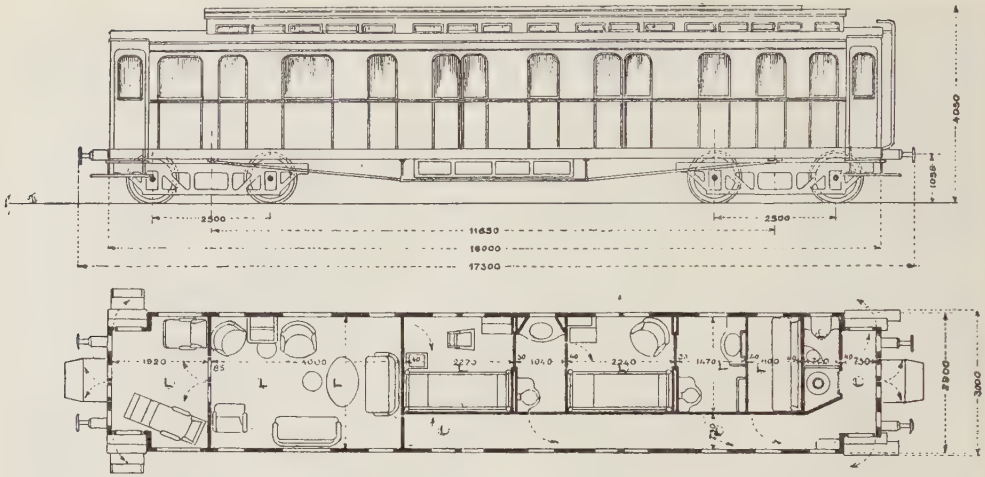


Fig. 5. — Drawing-room car with two bogies, built in 1888.

with the number of Ministers and the division of governmental duties amongst them, government control over the Bulgarian State Rys. from 1888 till 1893 was in the hands of the Minister of Finance, from 1894 till 1911 in the hands of the Minister of Public Works, and since 1912 has been held by the Minister of Railways, Post Office and Telegraphs.

2. Administration.

From 1888 till 1900, the administration of the railways was in the hands of the Railway Section of the Public Works Department, which was part of the Ministry of Finance up to 1893, and from 1893 till 1900 of the Ministry of Public Works.

From 1901 till 1907, the administration was in the hands of the Railway Management dependent on the Ministry of Public Works.

In 1908, the administration was handed over to the General Management of Railways and Harbours, which up to 1911 was part of the Ministry of Public Works, and after 1912 part of the Ministry of Railways, Post Office and Telegraphs.

In 1908, a Permanent Council was formed within the General Management of Railways, Post Office and Telegraphs, which included the General Manager and all the higher officials, including the heads of sections. The functions of this Council are consultative.

3. Staff employed to build the railways.

The first State line, Serbian frontier-Caribrod-Sofia-Vakarel (114 km. = 70.8 miles), was built by a Bulgarian firm with the help of many foreign technical experts.

Foreign experts still helped with the construction of the succeeding State lines, but gradually were replaced by Bulgarians who had in the meantime received the necessary technical training. It can therefore be stated that the Bulgarian railways have nearly all been built under the guidance of Bulgarian technical experts.

4. Recruiting and training the railway staff.

On the Roussé-Varna private line and the lines in South Bulgaria, the staff consisted almost entirely of foreigners

(English, French, Germans, Armenians, Greeks, Jews and Turks), and a minority of Bulgarians who could speak French or English. After the Roussé-Varna line was purchased, very few of the foreigners remained in the employment of the Bulgarian State Rys., and the necessary staff was completed to a large extent by men from the Post Office and Telegraphs Department. The same thing happened in the case of the first line forming part of the Vienna-Constantinople international line, the staff for which was recruited amongst Bulgarians employed on the private lines in South Bulgaria, and Post Office and Telegraphs employees.

Once the difficulty of recruiting staff for the first lines of the Bulgarian State Rys. had been overcome, recruiting was greatly facilitated by the rapid development of education in Bulgaria, which increased the number of candidates for railway service.

The training of the operating staff took place as follows : The young recruits had to have reached a given educational standard; they had to serve as probationers in the different departments, for a certain period at the end of which they sat for special examinations. After having passed these examinations successfully, candidates were appointed to the corresponding departments of the State Railway service.

In 1922, a special school was opened for the training of men for the traffic and commercial departments, locomotive drivers, guards, and foremen for the maintenance of the permanent way.

During the last few years, temporary periodical courses of instruction were given to complete the training of most of the State Railways' employees.

5. Number of railway staff.

As the system was extended and the volume of traffic increased, during the fifty years in question, the number of employees also greatly increased, as shown by the following figures :

Year.	*Total number of employees.*
1889	975
1909	6 431
1929	15 975
1937	17 231

These figures show that the number of men employed has increased in the ratio of 1 to 25. This increase would have been still greater if the output of work of the staff had not increased at the same time, as shown by the following figures :

Year.	*Thousands of units of traffic : Average per employee.*
1889	30
1909	60
1929	83
1937	85

This shows that during the period in question, the output of the staff has been nearly trebled. This favourable result is due above all to the increased density of the traffic and the technical progress made by the railway, especially as regards the rolling stock.

6. Remuneration of the railway staff.

The evolution of the wages paid is shown in the following table :

	Average wages per employee in gold-leva (*).
1889	1 700
1895	1 600
1909	1 254
1929	1 252
1937	1 187

During the first few years of their existence, the Bulgarian State Rys. required many more men than they could obtain, with the result that during this period the remuneration was high, especially when the cultural and economic standard in Bulgaria at that time are taken into account. Gradually the number of men required diminished and

(*) One gold leva equals one gold franc.

the number of men available increased, until latterly the supply has greatly exceeded the demand. This great change in the ratio of the supply to the demand explains the successive decline in the remuneration paid during the fifty years in question. As the figures given above show, during the last few years of this period the wages have been 40 % less than in the first few years, though they should now be much higher if the standard of economic development and culture of the inhabitants of Bulgaria during the period in question be taken into account.

The figures given above show that compared with the wages paid in other more developed countries, those received by Bulgarian railway employees are much lower. This is in accordance with the respective standards of economic and cultural values of the said countries and Bulgaria, according to which the price of labour, and generally speaking, the cost of living is lower in Bulgaria.

Wages account for 90 % of the expenditure on staff, and the remaining 10 % for various items, including expenditure on uniforms.

Uniform was supplied, either completely or partially. At the beginning of the period under review, only a very small proportion of the staff was supplied with uniforms, but at the present time nearly all the staff is provided therewith. In 1937 this item cost on the average 24 gold-leva per employee. These variations in the supplementary costs for uniform explain the change in the appearance of the Bulgarian Railway staff shown in Figs. 6 and 7.

In order to give the staff a personal interest in obtaining good output, both as regards quality and quantity of work, in 1923 a system of monthly premiums was introduced. To obtain the desired result, this premium depended entirely on the receipts from special additional charges, above all those charged for reduced transit times in the case of goods carried by rail.

The results obtained with these monthly premiums were good, especially as regards the improvement of the goods traffic : nearly 80 % of all consignments were delivered 1 to 3 days sooner than the transit times laid down in the Berne Convention for international traffic (C. I. M.). Owing to the standardisation of the wages of State employees in Bulgaria, however, the monthly premiums of the railway staff were suppressed after 1931. Part of these premiums was included in the wages of the railway staff, while the receipts from the special supplementary charges levied were included in the ordinary railway receipts.

From 1923 to 1930, the premiums were on the average 200 gold-leva per employee per year. At the same time as these monthly premiums, an insurance scheme for the State railway staff was introduced, and this was continued, even after the monthly premiums were discontinued.

After 1923, insurance against accidents at work was introduced for State Railway employees.

In the case of fatal accidents, the heirs received 1 900 gold-leva up to 1929, and since that date 1 100 gold-leva; in other cases the employee concerned is given a sum in proportion to his injuries and resulting incapacity. The premiums for this insurance were paid by deductions from the monthly premiums between 1923 and 1930, and since 1931 have been charged to staff expenditure. This item now amounts to 30 000 gold-leva per annum in round figures.

In 1925 an insurance scheme was introduced for death not due to accident, for sums varying from 700 to 1 500 gold-leva, according to the salary of the employee. The premiums for these insurances were paid by deductions from the monthly premiums of all the railway staff. These insurances were increased and improved by the Assurance and Mutual Aid Society for Railways and Harbours staff, created at the beginning

Fig. 6. — Staff uniform in 1890.

of 1930, and known by the abbreviated name of « Railway Society ».

According to the law instituting this Society and its rules, it is a self-contained assurance organisation working according to the theory and practice of insurance companies, with the assistance and under the control of the State Railway Administration.

All the railway staff (including permanently employed workmen) must be members of this Society. They are entitled to remain members even after leaving the employment of the railway.

Each member of the Society is free to choose what scale of premiums he will pay, no matter what his salary; these premiums vary from 40 to 80 gold-leva for an insured capital of 1 000 to 4 000 gold-leva, the greater part of which is payable during the life of the insured, after a term of 20 years.

This system of insurance replaced that in existence between 1925 and 1929 for railway employees only, for which the premiums were 18 gold-leva per person insured. For this reason in the rules of the Railway Society it is laid down that the Railway Administration will pay an annual premium of 18 gold-leva for each employee in service. During the period 1930 to 1937 this amount-

Fig. 7. — Staff uniform in 1938.

ed to 300 000 gold-leva a year. As a result the men actually employed by the railway who are members of the Society only have to pay premiums of 22 to 62 gold-leva, whereas other members pay 40 to 80 gold-leva a year.

On its inauguration in 1930 the Railway Society had 16 593 members insured for the sum of 30 million gold-leva. At the end of 1937 there were 19 656 members (2 210 being former State Ry. employees) insured for a sum of 34 million gold-leva in round figures. During the years 1930 to 1937, 862 members died, and their heirs benefited to the sum of 1.6 million gold-leva. The reserves of the Railway Society were only 0.5 million gold-leva at the end of 1930, whereas at the end of 1937 they amounted to 6 million gold-leva. Towards the end of 1937, 1.7 million gold-leva of the reserves were in the form of ordinary loans on insurance policies, 1.3 million gold-leva as loans on mortgage to assist in the purchase of dwellings — for members and their near relations — 1 million gold-leva in house property, and 0.5 million gold-leva in dwellings sold to members and repayable over a long period.

Side by side with the Railway Society, there is also a special fund for the assistance of members in case of serious illness, or unemployment, but with no pension rights. There is also a special fund for the education of promising children of members of the Society, by means of scholarships.

All this shows that the setting up of the Railway Society was a very appreciable step forward in the assurance of the Bulgarian State Rys.' staff.

(To be continued.)

NEW BOOKS AND PUBLICATIONS.

[656]

TREVISANI (Renato), professor of political and financial economy, and transport economics, Royal University of Triest. — **Compendio dei Trasporti** (Abstract of transport economics). — A volume (6 × 8 1/2 inches) of 552 pages. — 1939, Milan; Dott. A. Giuffrè, publisher.

The Author in this work studies the different methods of conveyance by land, waterways and airways. He examines the scope, efficiency, usefulness and possibilities of each method.

In the first and introductory part, he shows that transport is dependent on economics, but also on political economy; he then states the fundamental principles which should be borne in mind if a true estimate is to be made of certain facts, viz. the value of transport, the cost of transport and the price of transport. In the case of the large public undertakings, an important problem to be solved is to know in which way the State can or should take a hand in their management or their financing. Chapter II ends with considerations about this matter.

It would be a difficult task to summarize here, even briefly, this work, to which the Author has given a somewhat unassuming title (compendio = abstract). Two parts of about equal length deal, the first with land transport, the other with waterways.

Land transport, with which our readers are most concerned, includes conveyance by rail and by road. They have different technical characteristics which the Author analyzes before studying the price of transport and especially the various factors of which it is made up. A special chapter is devoted to relations between road and rail, and another to the present position of automobile transport in Italy. In the latter the Author defines the aims of the public authorities and states the legal and financial measures already in force.

In the third part, the Author reviews sea transport, harbours, ship canals and inland waterways. Here also he expounds the technical aspect of things, the management and financing of the undertakings and their dealings with the State, the splitting up of the operating expenditure, the efficiency of transport and its utility as regards the economic system of the country as a whole.

Airways, the subject matter of the fourth part, are dealt with in a similar way. This part has two chapters : the first treats airway economics, the second shows the intervention of the State in this field.

The last part is headed : — Particular aspects of the Italian transport policy. The Author here examines the effects of the Corporative policy on the organisation and operation of transport as a whole, as well as the steps which had to be taken as a consequence of autarcy, and their results. In a last chapter — Transport in the Empire — the Author shows the pressing need for transport in Africa, and outlines the schemes under consideration.

E. M.

[625. 253]

HILDEBRAND (Dr. Ing. e.h. W.). — **Die Entwicklung der selbsttätigen Einkammer-Druckluftbremse bei den Europäischen Vollbahnen** (*The development of the compressed air brake on European main-line railways*). — A volume (10 1/2 × 8 inches) of 84 pages, with 64 figures and 2 inset plates. — 1932, Berlin : Julius Springer, publisher. (Price : 9.60 RM.)

Dr. Hildebrand's book is a supplement to the treatise he has already published on the automatic compressed air brake, also known as the single-chamber brake;

he deals with recent improvements in such types of compressed air brakes.

The first chapter is devoted to the question of regulating the brake pressure, and the Drolshammer and Bôzic types of single release brakes, mentioned in the original volume, which are now sanctioned by the International Railway Union, are described. The author then deals with brakes releasing in stages and including two control valves, and in particular with the Breda and Hildebrand-Knorr types. The subsequent chapters deal with devices for reducing the pressure in the case of the empty and loaded wagon brakes; pressure regulating devices for high speeds; accelerators for goods trains in order to increase the speed of propagation of the brake action; automatic drivers' valves; and finally the different types of Hildebrand-Knorr brakes for goods trains, ordinary passenger trains and express trains.

An appendix gives the regulations laid down by the International Railway Union as regards the continuous brake on goods trains and on passenger trains, as well as a table showing the leading features of the brakes for goods trains, accepted by the International Union : Westinghouse, Kunze-Knorr, Drolshammer, Bôzic, Breda, and Hildebrand-Knorr.

The book is copiously illustrated, and includes two coloured plates showing the working diagrams of Hildebrand-Knorr brakes for goods trains.

A. C.

[656.235 (.43)]

COUVÉ (Dr. Richard), Reichsbahnrat. — **Die Eisenbahn-Güterabfertigung** (*Despatching goods by rail*), 5th edition. — Two volumes (8 × 5 1/2 inches) of 278 and 214 pages respectively, illustrated. — 1939, Leipzig : published by the Verkehrswissenschaftliche Lehrmittelgesellschaft m.b.H. (Price : 2.06 RM. per volume.)

The author had a didactic object in writing this book; it is intended for railway employees taking examinations on the working of the goods department of railways. The work covers all the necessary operations, formalities, papers, etc., to be attended to by the railway staff at the departure station, en route, and on arrival.

The first volume includes chapters dealing with the acceptance of goods, their loading, and the operations on their arrival. The goods are followed from the time they are accepted by the railway and are loaded into wagons, including their weighing, preparing the waybill, obtaining the necessary wagons, transport documents, travel, etc., for both full wagon loads and small consignments, until their delivery to the consignee.

The second volume deals in detail with commercial questions affecting the rolling stock department responsible for allocating and using the rolling stock. A chapter is devoted to the rates. Another deals with the liability of the railway in the event of loss, damage or delay. Another again covers under or excess weight. The last chapter reviews a certain number of the customs, fiscal and police regulations.

Whenever it is useful to do so, the author points out the administrative instructions to be applied. He shows the distinction to be made between internal and international traffic. He quotes the international agreements about goods wagons and explains the essential clauses.

This work is a complete vade-mecum for the goods office clerck, as it shows him at every turn and in every case what should be done, by reminding him of the official regulation or document to be consulted.

E. M.